ALTAI Super WiFi

ALTAI B5 WIRELESS BRIDGE

CONFIGURATION MANUAL

Version 1.0

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Altai Technologies Limited

Unit 209, 2/Floor,

East Wing, Building 17

Hong Kong Science Park,

Sha Tin, New Territories,

Hong Kong

Telephone: +852 3758 6000

Fax: +852 2607 4021

Web: www.altaitechnologies.com

Customer Support Centre:

Email: support@altaitechnologies.com

Radio Frequency Interference Requirements

This device complies with Part 15 of FCC Rules.

Operation is subject to the following conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.
3. This device should not be co-located or operating in conjunction with any other antenna or transmitter.

Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This

equipment generates uses and can radiate radio frequency energy. If it is not installed and used in accordance with the instructions, harmful interference to radio communications may be caused.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: To assure continued compliance, (example – use only shielded interface cables when connecting to computer or peripheral devices) any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Warning

The user is advised to keep away from the base-station and antenna with at least 45cm when the base-station is in operation.

Please install a lightning arrestor to protect the base station from lightning dissipation during rainstorms. Lightning arrestors are mounted outside the structure and must be grounded by means of a ground wire to the nearest ground rod or item that is grounded.

Disclaimer

All specifications are subject to changes without prior notice. Altai Technologies assumes no responsibilities for any inaccuracies in this document or for any obligation to update information in this document. This document is provided for information purposes only. Altai Technologies reserves the right to change, modify, transfer, or otherwise revise this publication without notice.

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I. Getting Started

This Technical User Manual contains the description of Altai equipment including installation and configuration guidelines, recommendations and troubleshooting sections, supplementary materials. The document is intended to be used by Qualified RF engineers/technicians and IT professionals. Qualified personnel should have skills and experience in the following areas:

- Outdoor/indoor radio equipment installation
- Outdoor wireless networks
- TCP/IP networking protocols
- Safety procedures and instructions for installing antenna equipment
- Professional manage of electrical equipment and accessories
- Safety procedures and instructions for working on towers and heights

1. Scope of document

This document consists of the following chapters:

Getting started

This chapter includes the information about this document purpose and structure.

Hardware description

This chapter shows the devices appearance and all plugs and connectors.

Installation procedure

The chapter describes the steps to be taken when installing the equipment at the installation sites and installation site requirements.

Device configuration procedure

This chapter includes basic recommendations for primary link configuration, including interfaces configuration and MINT protocol usage. Also there is a description of how to perform basic manipulations with device's configuration including its updating, importing and exporting.

Link configuring

The chapter contains basic recommendations for making preliminary choices and decisions while planning and deploying a wireless network

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based on Altai Devices. It also describes a set of tools that can help while improving the link quality and statistics gathering.

Services, features and tools

This chapter describes device's built-in services, features and tools which were not described in previous parts of the document

Recommendations

The chapter contains different recommendations for some particular cases of Altai devices usage including building high-speed autonomous links and multi-sectored base station design.

Supplementary information

The chapter contains supplementary information (specifications, connectors soldering schemes and Altai products matrix).

2. General product description

The Altai B5 Wireless Bridge is designed to be used in Altai Super WiFi systems to provide carrier-grade ultra-long range and high throughput backhaul bridging.

The Altai B5 comprises of a number of high performance antenna options which operate in both LOS and NLOS environments, in both licensed and unlicensed frequency bands.

Featuring highest performing hardware and operating system coupled with most innovative radio technology providing with best sensitivity, increased output power across all modulations and wide dynamic range, Altai B5 represents a perfectly balanced solution for any type of Point-to-Point connectivity.

The Altai B5 is a wireless Point-to-Point solution which combines high-speed capability, up to 240 Mbps throughput, with a rich set of best-in-class features and benefits such as leading-edge radio protocols providing unrivalled spectral efficiency and wireless transmissions over distances in excess of 80 km.

Altai's diverse range of solutions enables Service Providers of all types to build higher capacity networks with even fewer network elements, thereby significantly reducing their overall CAPEX and subsequent OPEX throughout the life of their network.

The Altai B5 product family is an optimal solution for mobile operators and all other service operators requiring multi-megabit capacity for their

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backhaul links. In all these applications, our solutions offer operational cost saving benefits such as quick deployment, ease of configuration and the ability to upgrade existing infrastructures via software download to cater for new requirements (i.e. "pay as you grow").

Altai B5 Wireless Bridge provides the most cost effective and versatile way for backhaul provisioning in terms of its throughput capacity or range. When combined with the A8 Super WiFi Base Station, it can create possibly the most cost-effective high capacity wireless broadband network system.

3. Abbreviations

The following abbreviations are used in this document:

- BS – Base Station
- CPE – Customer Premises Equipment (also called **subscriber** or **subscriber unit**)
- ODU – Outdoor Unit
- IDU – Indoor power supply Unit
- RF cable – Radio Frequency cable to connect ODU and antenna/Device and antenna for B5 modifications correspondingly
- LOS – Line-of-Sight
- STP cable – Shielded Twisted Pair cable (STP Cat5E) to connect ODU and IDU
- PTP – Point-to-Point topology
- PTM – Point-to-Multipoint topology
- MINT – Mesh Interconnection Networking Technology protocol

4. Document marks

All warnings are marked with a special warning sign. One should pay a great deal of attention to what is written in the Warning sections.

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All notes are marked with a special note sign. Notes usually contain useful comments or hints to the described section of the document.

5. Additional information

Additional information which is not included in this Manual can be found in the following sources:

- Our web-site: **http://www.altaitechnologies.com/**
- Our support site:

  http://www.altaitechnologies.com/partners_extranet.php

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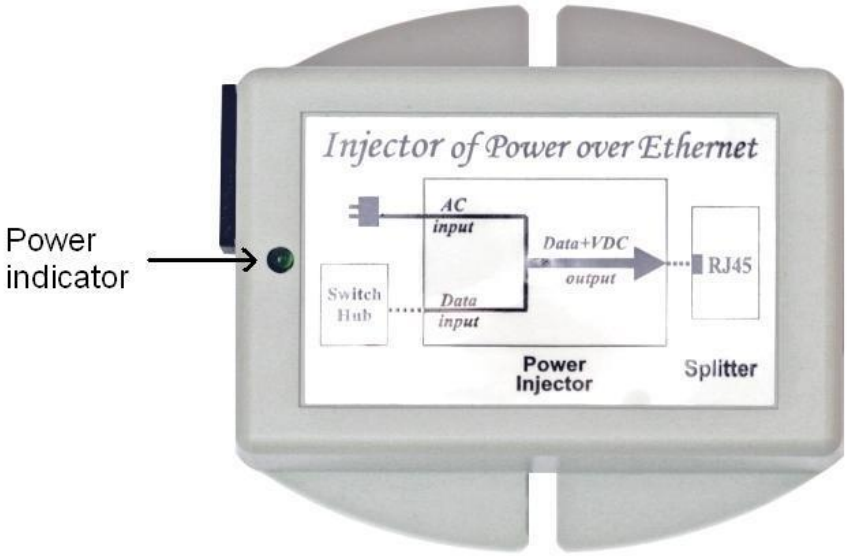
II. Hardware description

1. Power supply units (IDU)

All outdoor equipment is equipped with indoor power supply units.

IDU-B5 Lite

Top view



Front panel

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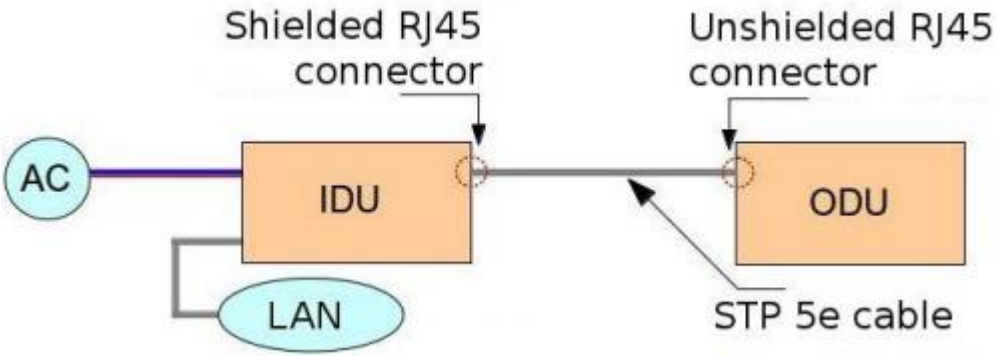
Rear panel

Connection scheme for IDU-CPE



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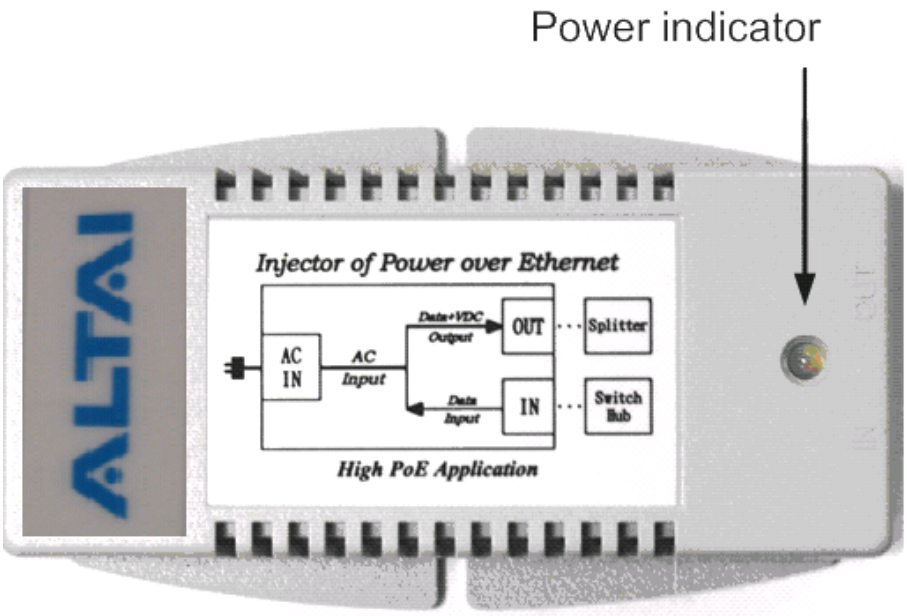
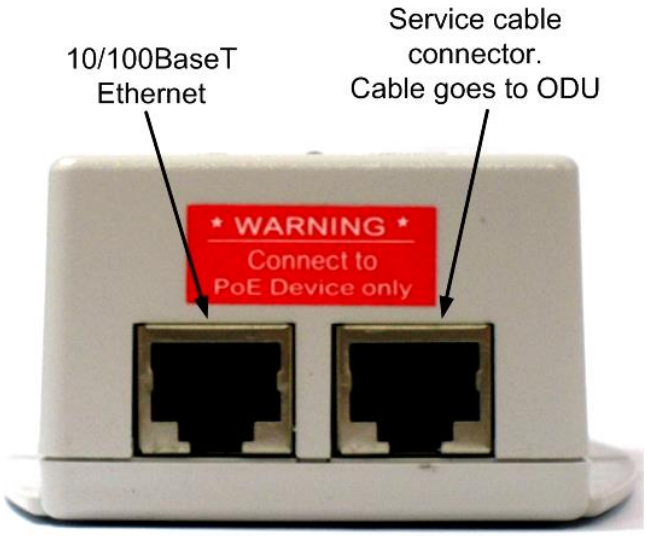
IDU-B5

Top view



Front panel



*IDU-B5 model has 10/100/1000BaseT Ethernet port

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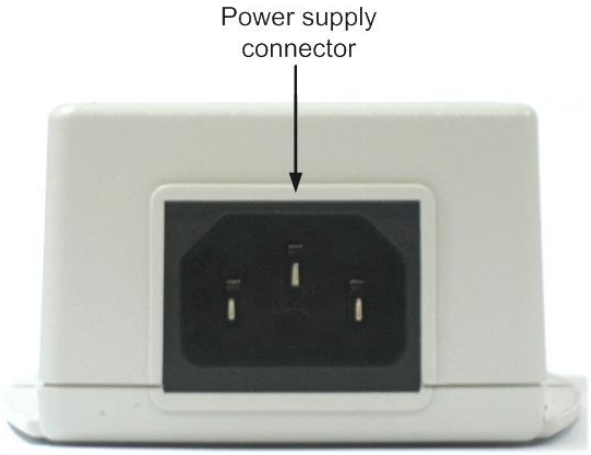
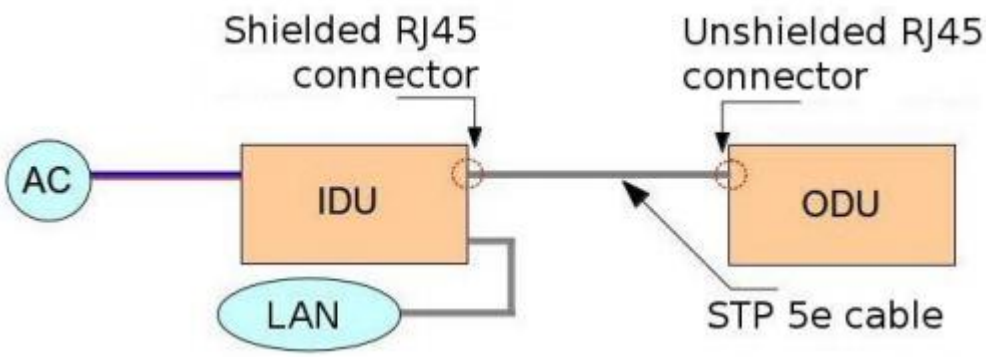
Rear panel



Connection scheme for IDU-B5



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2. Outdoor Units (ODU)

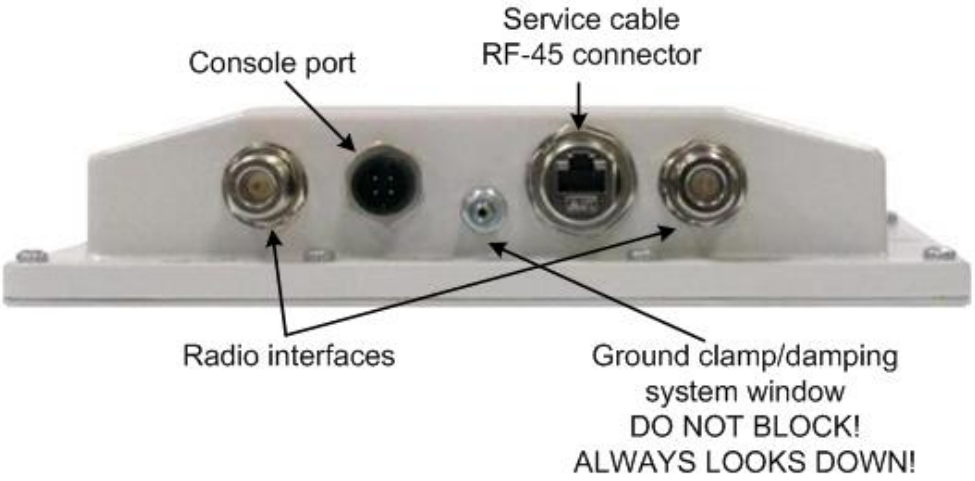
B5 with 2 external antenna ports

IDU

Default factory option: IDU-BS.

ODU

Front panel



Top view

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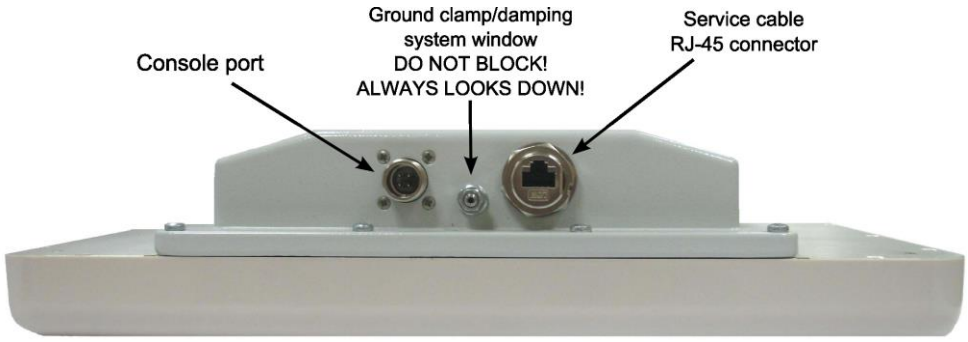
B5 with integrated panel and B5 Lite with integrated panel

IDU

Default factory option: IDU-BS.

ODU

Front panel



Top view

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ODU LED indicators description

Altai ODU units have two LED indicators (red and green) located in the Console connector. These LEDs are useful in monitoring the device status during the installation procedure. LEDs modes and Device status correspondence is shown in the following table:

Red indicator	Green indicator	Device status
Off	Off	Device is switched off of in the process of start-up booting
Off	Blinking	Device is booted. No radio connection. Searching for another device to establish radio connection to.
Blinking	On	Radio connection established. The more data is transmitted through the radio channel the more frequently red indicator is blinking.

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III.Installation procedure

1. Installation preparations

Required components and accessories

Before the installation, please make sure you have all necessary parts and accessories:

- Altai B5 Device
- Antenna
- Low loss antenna cable for the required frequency range
- Antenna pole (if necessary)
- Required grounding system
- Accessories and tools

Antenna placement

When planning an antenna placement for PTP link, in order to obtain the maximal coverage range and best performance for the Device, one need to consider that LOS requirements must be fulfilled for the path between two antennas. Moreover, it is of vital importance that the certain zone that surrounds the signal propagation path must be free from obstructions. One should understand that the radio beam is not as thin as, for example, laser beam. Radio beam, also called as a 1st Fresnel zone, has a profile of a rugby ball. Its exact form and size depend upon the frequency and the signal propagation path length.

If most of the 1st Fresnel zone is obstructed, a major part of a electromagnetic energy will be lost which leads to a severe signal quality degradation and, as a result, to coverage range decreasing.

Below is an incomplete list of possible obstructions on the signal propagation path:

- Neighboring buildings
- Trees
- Bridges
- Power lines

To obtain the best results, it is necessary to perform a precise analysis of a signal propagation path zone and possible obstructions that may

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cover a part of the 1st Fresnel zone (usually the analysis is performed at the highest points of the signal propagation path).

When planning the antenna placement for Point-to-Multipoint connections, one must consider the necessity of a circular or sector coverage areas. In this respect, it is not recommended to use omni-directional antennas when sector antennas can be used.

While planning, it is strongly recommended to consult high-qualified and experienced technicians

General recommendation for antennas placement are the following:

- Install antennas as high as possible over specific level. In case of flat surface - it will be ground level, in case of vegetation and forest – it will be tree heights, in urban environment – it will be the highest building in the observed area (specific level definition).
- Avoid tree and vegetation along with wave propagation path, influence of trees can increase depending on seasons (ice, dew, leaves);
- Proximity of other antennas should be avoided (at least 2 meters);
- Reflecting surfaces should be considered (building with reflective windows, water surfaces or wet grounds);
- When installing antenna over water surface, one should tune height bracket within 1-3 meter range variation, because it can yield signal level variation from minimum to maximum.
- If seasonal changes influence on the signal quality, so then the most probable reasons would be either the connectors are not protected enough from humidity, summer vegetation or ice covered cabling and connectors during winter.

Antenna poles usage

Antenna installation is performed on a special facility called antenna pole. The pole is used for strong antenna tightening at the installation site. Poles might have different modifications depending on the installation requirements.

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Poles with Stretching

Usually this kind of poles are used when installing antenna on a flat surface and permits one to raise it to a significant height for providing optimal conditions for signal propagation.

Wall Mounted Pole

Usually these kinds of poles are used when there is no need to elevate antenna to the rooftop and there is the possibility to mounting it on a wall. This installation is significantly simpler than that implementation with poles. Mostly it is used for subscriber side deployments.

Antenna Poles Requirements

Ease of antenna mounting and sufficient mechanical durability should provide reliable fastening in conditions of high windy loads. Poles should have round profile for ease of azimuth adjustment. Typical pole diameter is 30 to 50 mm.

Grounding

Antenna should be placed on the mast on the level that is at least 1 meter lower than a mast's top. In this case it is of big probability that the lightning strikes the mast and not the antenna. The mast is to be grounded on the grounding contour according to your local standards. When the lightning strikes the antenna, the current goes through the coaxial cable which grounds ODU clamp with the mast – the mast is grounded via the grounding contour. The direct lightning strike to the STP service cable (ODU-IDU) is partially terminated on the grounded IDU case. Partial termination means that the direct lightning strike will probably destroy an STP cable. The service cable pickups from the electromagnetic impulses are terminated on the IDU case by the winding shield, and further – on the IDU grounding.

The end of the STP service cable that is connected to IDU should be assembled with a Shielded RJ-45 connector. The other end of the STP service cable (connected to ODU) should be assembled with unshielded (standard) RJ-45 connector.

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IDU is grounded via a three-conductor power cord and a plug containing a ground. The data & power wires pickups are terminated via IDU protection scheme (three-conductor power cord and a plug containing a ground).

ODU grounding contour are connected with 100kOhm resistor, and that provides no static charge accumulation on the ODU case if there are some problems with its connection to the grounding contour.

Antenna pole, tower, ODU and lightning arrestor should be connected to the first common grounding contour. Cable thickness should be no less than 10AWG using corrosion-steady connectors. IDU should be grounded to the same contour as customer LAN, having the second common grounding contour.

A special attention should be paid if antenna used is not DC-shorted. In this case additional lightning arrestor should be used between the antenna and ODU. Suggested grounding diagram is shown on the picture below.

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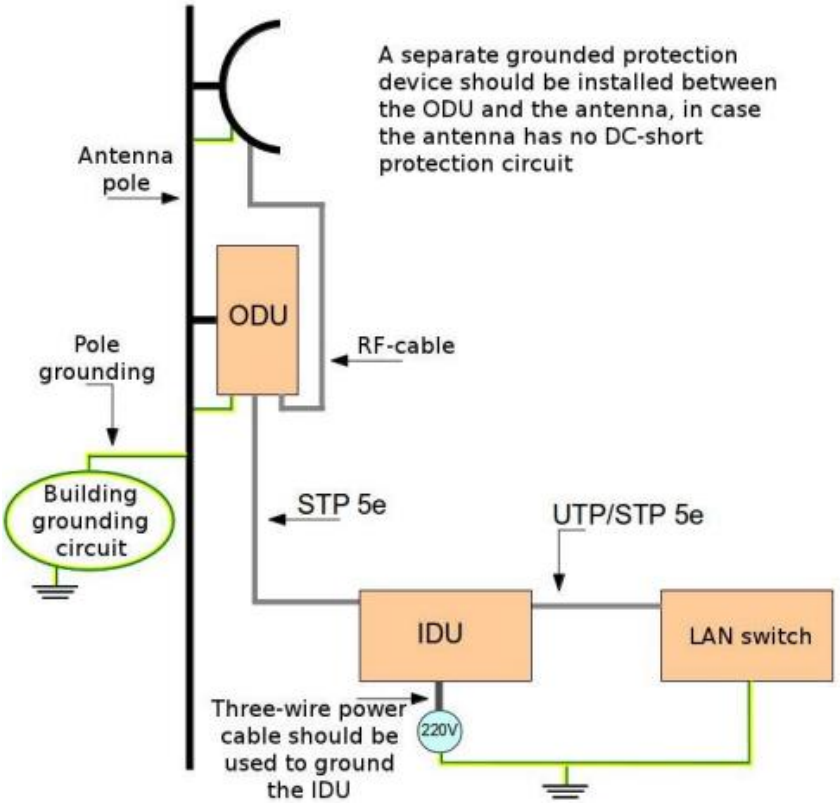
A separate grounded protection device should be installed between the ODU and the antenna, in case the antenna has no DC-short protection circuit
Antenna pole
ODU
RF-cable
Pole grounding
Building grounding circuit
STP 5e
UTP/STP 5e
IDU
LAN switch
Three-wire power cable should be used to ground the IDU
220V

Antenna alignment

To obtain maximal system performance antennas must be precisely aligned one towards another according to LOS requirements. General recommendations for antenna alignment are the following:

- Align antennas using optical equipment (binoculars, spyglass) accompanied by mobile phone actions coordination
- Use GPS receiver and area map
- Use build-in Altai B5 Device features. These features allow evaluating current channel/signal quality and perform precise antenna alignment

Omni-directional and sector antennas have a wide radiation diagram width, thus usually they either do not require a very precise alignment or it is just not necessary due to radio link requirements.

Antenna polarization must be taken into consideration while installation. In most cases omni-directional and sector antennas have a vertical polarization. Directional antennas can be installed either with vertical or horizontal polarization. Please check a corresponding

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labeling on the antenna and address to the antenna technical documentation.

Precaution measures

Before you start the installation please read this section very carefully.

Antennas are installed on the roof tops or on the building walls. This work must be accomplished only by personnel having special skills and experience in this area.

Antennas and cables are electric conductors. Incidental electrostatic strikes may occur during the system installation. This can lead to equipment damaging or may hurt the personnel. While installing or changing the elements of the antenna-feeder system one must make sure that open metal parts are temporarily grounded.

Do not install the antenna close to the electric power lines. Antenna and antenna pole have to be installed in such a way that while their assembling, disassembling and repairing they did not have any contact with power lines.

Basic precaution measures that must be fulfilled during the installation are the following:

- Do not stay on the roof top in windy or rainy weather, during the thunderstorm or when the working zone is covered with snow or ice
- Do not touch the antennas, antenna poles, cables and lighting arrestors during the thunderstorm
- Antenna placement should not be close to electric or telephone lines. Safe distance is a distance that is a sum of the two antenna poles heights and antenna height
- Antenna cable must be grounded at all times (not relevant for B5 modifications)

In case of failure any manipulations with the equipment are allowed to skilled personnel only.

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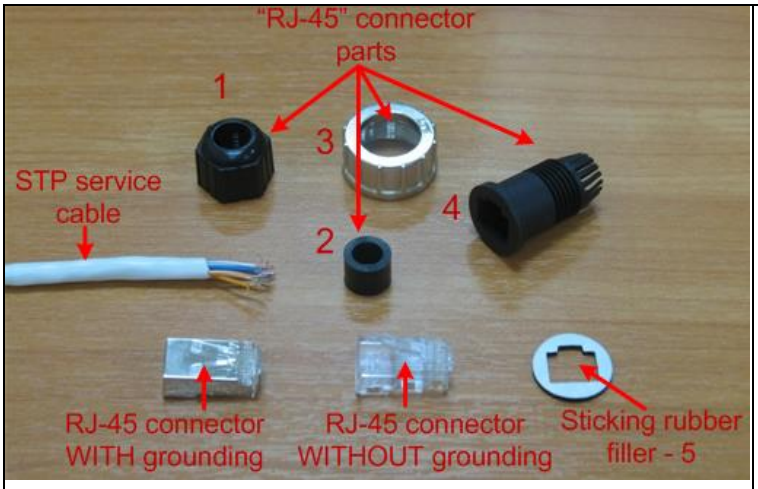
Service cable soldering procedure

"RJ-45" connector

The following instruction shows the "RJ-45" connector soldering procedure.

	Step 1. Peel STP service cable and prepare "RJ-45" connector parts. Use RJ-45 connector without grounding here (RJ-45 connector with grounding is used for connecting service cable to IDU).
	Step 2. Stick rubber filler – 5 on the Part 4, previously having removed protective white layer from rubber filler -5. Insert Part 2 inside part 4 up to the stop. Part 2 must be entirely within Part 4.
	Step 3. Put connector parts on the STP service cable as shown. Attach RJ-45 connector without grounding to the STP service cable according to the "RJ-45" soldering scheme (in the "Supplementary information" chapter of this manual) and crimp the connector using a crimp tool. ⚠ Please tightly crimp the RJ-45 connector. Not

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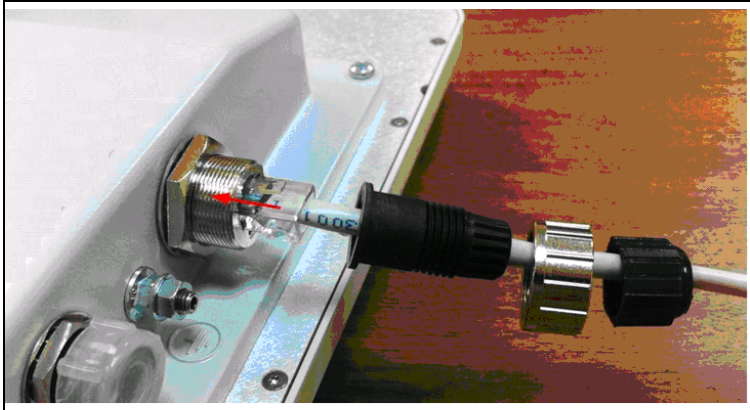
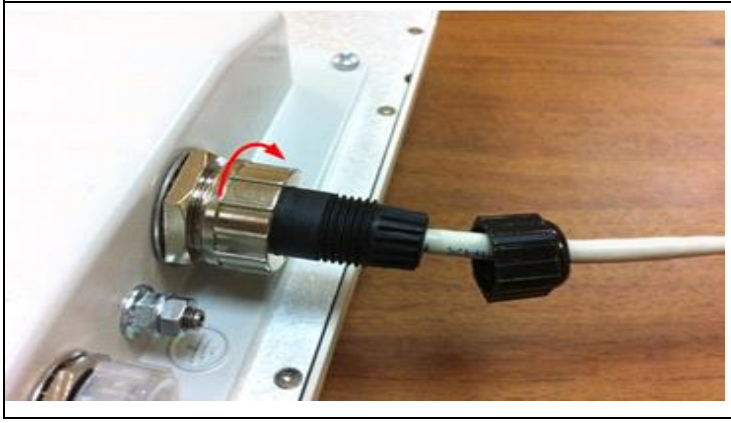
	crimped or badly crimped connector damages the unit when assembled into it which is not considered as a warranty case.
	Step 4. Connect the attached RJ-45 connector to the unit until you hear a click.
	Step 5. Put Part 4 on the RJ-45 connector.
	Step 6. Screw Part 3 onto the unit's connector tightly.

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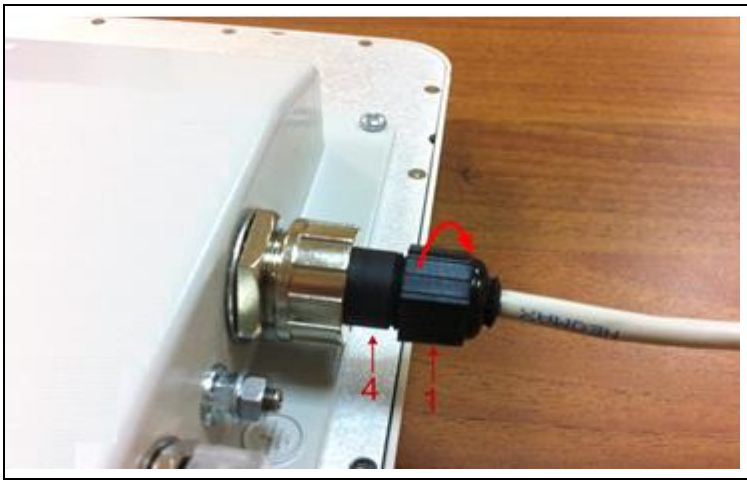	Step 7. Screw Part 1 onto Part 4 of the RJ-45 connector as tight as possible. Now the connector is hermetically attached to the unit.

Tools to be available at the installation site

1. Screwdrivers set
2. Pliers
3. Spanners set
4. Connectors isolating set
    - Raw rubber
    - Thermal shrinkage tube
    - Scissors
    - Fan
    - Mantling gun
5. Additional equipment
    - GPS receiver or area map (with compass and alidade)
    - Big zoom binoculars

2. B5 with 2 external antenna ports

Installation guidelines

1. Unpack the equipment
2. Check items integrity
3. Prepare RF-cables of the required length. For 5GHz devices the recommended maximal RF cable length is 1 meter.

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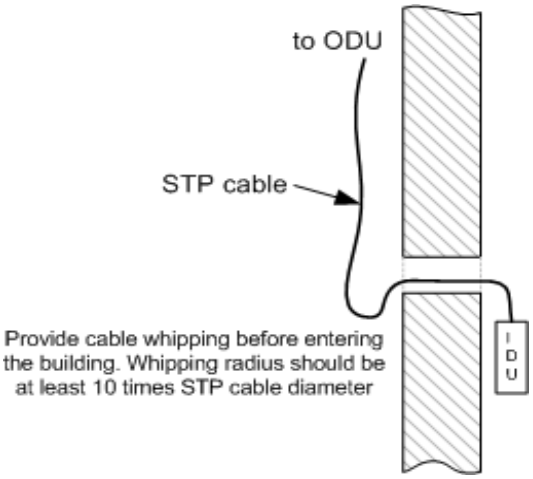
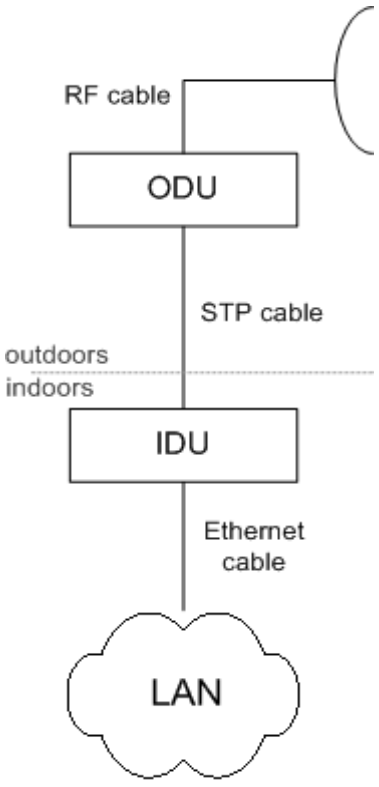
4. Install and isolate the connectors on the RF cable
5. Determine the STP cable length that is used to connect IDU and ODU. The total cable length between LAN (behind IDU) and ODU should not be longer than 100 meters. Service cable connecting IDU and ODU should be STP Cat 5E cable.


to ODU
STP cable
Provide cable whipping before entering the building. Whipping radius should be at least 10 times STP cable diameter
IDU

6. Install (solder) connector for ODU on the STP cable and isolate it
7. If it is possible to lay STP cable with a connector on the IDU side, install (solder) connector for IDU on the STP cable and isolate it
8. Lay the STP cable "from top to bottom" – from ODU to IDU
9. If step 7 is not accomplished, after the STP cable has been laid, install (solder) connector for IDU
10. Install ODU on the mounting bracket connectors down and tighten it
11. Connect the ODU-IDU cable to the ODU
12. Isolate the ODU connector joint place
13. Once the antenna and antenna pole are installed they must be grounded via lightning protection grounding contour. Antenna's position must be lower than the highest antenna pole point at least by 2 antenna heights. If antenna is NOT DC-shorted (see antenna technical documentation), the additional lightning arrestor must be used which is placed between ODU and antenna and is grounded to the antenna pole grounding contour.



14. Connect RF cable to the antenna. Twist the connector tightly

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15. Connect RF cable to the ODU previously having touched RF cable connector case with ODU connector case
16. Isolate RF connectors from both sides (ODU and antenna)
17. Connect the STP cable to IDU previously having touched IDU connector case with STP cable connector case
18. Provide grounding for IDU
19. Connect Ethernet cable to IDU
20. Provide power supply for IDU
21. Connect to the Router using Telnet protocol

It is extremely important to install ODU connectors down!

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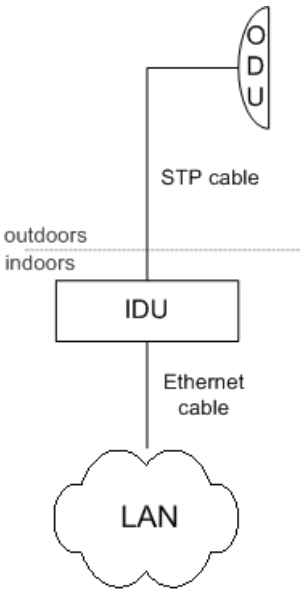
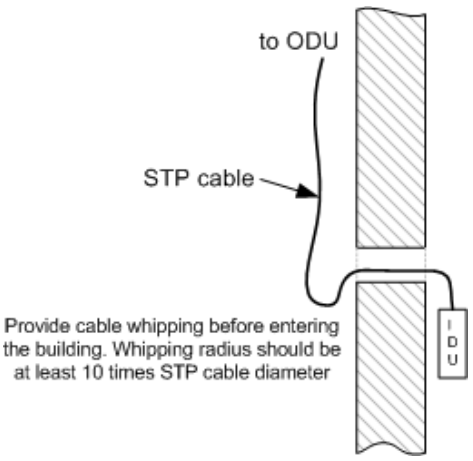
3. B5 with integrated panel and B5 Lite with integrated panel

Installation guidelines

1. Unpack the equipment
2. Check items integrity
3. Determine the STP cable length that is used to connect IDU and ODU. The total cable length between LAN (behind IDU) and ODU should not be longer than 100 meters.
4. Install (solder) connector for ODU on the STP cable and isolate it
5. Lay the STP cable "from top to bottom" – from ODU to IDU
6. After the STP cable has been laid, use distribution box to switch from STP cable to UTP cable with RJ-45 connectors. Service cable connecting IDU and ODU should be STP Cat 5E cable.
7. Install ODU on the mounting bracket according to the direction required for the link. Do not tight it too hard unless the antenna alignment is not complete. Install ODU connectors down.
8. Connect the ODU-IDU cable to the ODU
9. Isolate the ODU connector joint place
10. Once the ODU and antenna pole are installed they must be grounded via lightning protection grounding contour. ODU position must be lower than the highest antenna pole point at least by 2 ODU heights
11. Connect the UTP cable to IDU
12. Provide grounding for IDU
13. Connect Ethernet cable to IDU
14. Provide power supply for IDU




to ODU
STP cable
Provide cable whipping before entering the building. Whipping radius should be at least 10 times STP cable diameter
IDU

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15. Connect to the Device using Telnet protocol

It is extremely important to install ODU connectors down!

Mounting kit

Mounting kit features:

- Material: casted Aluminum
- Adjustment: two axis (vertical and horizontal)
- Mounting options:
    - standard pole (30-85 mm)
    - wall
    - thick pipe (>85 mm, horizontal/vertical) using additional fasteners (not included to the package)
- Compatible with all outdoor units produced by Altai
- RoHS compliant

General view

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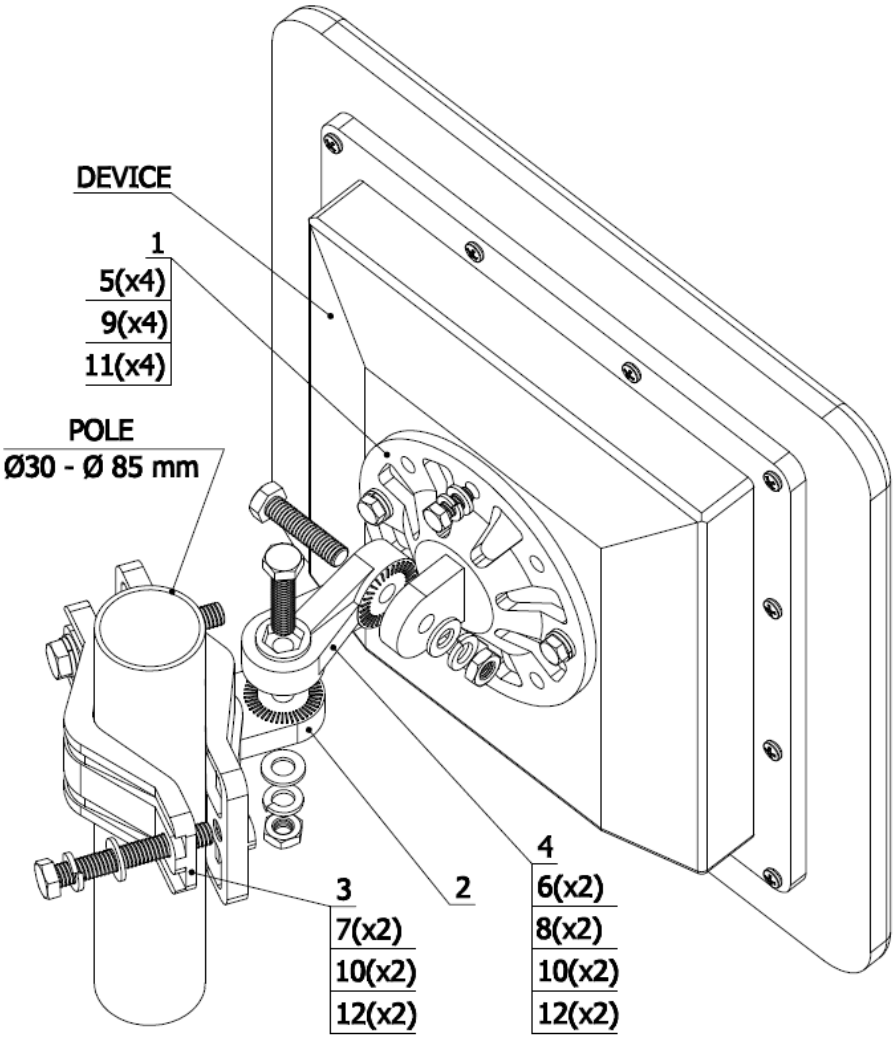
Assembly



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INSTALLATION INSTRUCTION

STEP 1:
Attach the Basement to the back of the device, using items 5, 9, 11.

STEP 2:
Tighten the Bracket and the Bracer to the pole, using items 7, 10, 12.

STEP 3:
Attach the Lever between the Bracket and the Basement, using items 6, 8, 10, 12.
Do not fasten the nuts!

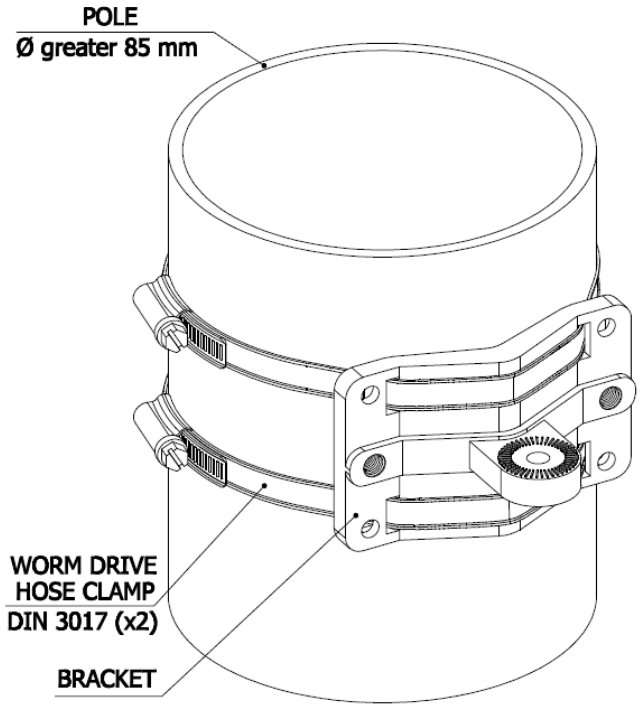
STEP 4:
Adjust the required tilt and fasten all nuts at the required position.

CONFIGURATION KIT

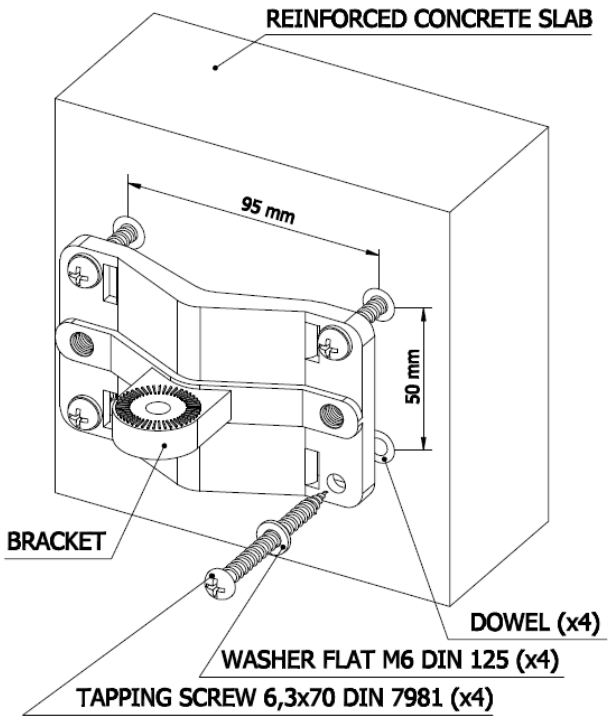
ITEM	DESCRIPTION	QTY
1	BASEMENT	1
2	BRACKET	1
3	BRACER	1
4	LEVER	1
5	BOLT M6X14	4
6	BOLT M8X35	2
7	BOLT M8X80	2
8	NUT M8	2
9	WASHER FLAT M6	4
10	WASHER FLAT M8	4
11	WASHER SPRING M6	4
12	WASHER SPRING M8	4

Possible variants of the installation

INSTALLATION ON A POLE OF BIG DIAMETER



INSTALLATION ON A WALL



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Attention! Mounting kit does NOT contain worm drive hose clamps or other additional fixtures used in possible variants of installation.

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IV.Basic configuration instructions

1. Initial settings configuration procedure

Before starting new device, one should perform initial configuration. The configuration can be performed either using serial console port or using Telnet protocol. In order to configure the device using Console port, follow the instructions below:

- Device should be connected with host serial interface, using Altai Console cable
- Start any terminal emulation software (e.g. Hyper Terminal)
- Set serial interface properties to 38400 baud rate, 8 bit, 1 stop bit, parity off, flow control disabled
- Enable emulation mode ANSI or VT100, keyboard VT100

To connect using Telnet protocol from the wired LAN run Telnet with 192.168.1.20 IP-address that is configured for the Ethernet interface of the device by default.

If all above procedures are completed correctly, you will see the Altai OS prompt:

Login:

For every new device, you can use the default Login and Password to enter the device:

Login: Altai

Password: wag

After default authorization there will be standard console prompt:

#1>

Now the device is ready for the initial configuration procedure. The most relevant thing to be done at this phase is to define device name/user/password.

system name Test Base Station

system user root

system password qwerty

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*Part of commands in **bold** must be typed in CLI (Command Line Interface). The rest of the command name is optional and can be skipped while typing.*

Since this is made ONLY specified username and password can be used to access the device. DO NOT FORGET THESE PARAMETERS.

2. Device interfaces

The Device has several physical and logical interfaces:

- **lo0** - loopback interface, used for system interaction needs
- **null0** – logical interface, can be used for auxiliary addresses assignation (for NAT module, for example); for routes aggregation for RIP protocol. Addresses (subnets) are announced to the network but every packet transmitted through this interface is destroyed
- **eth0** - Ethernet 10/100 Mbit interface
- **rfX.0** - radio interfaces. See device's labeling or use "ifconfig -a" command to learn your radio interfaces
- **wifi0** – Wi-Fi AP interface
- **pppX** – point-to-point interfaces
- **tunX** - interfaces used for IPIP tunnels building
- **vlanX** – interfaces supporting VLAN 802.1q tagging

All configured interfaces of the Device can be reviewed using the following command:

ifconfig -a

3. Command line interface (CLI)

For device's management and configuration a Unix-like command line language is used. Every command starts having the power right after Enter key is pressed. However, each command lifetime duration is limited within one configuration session. In order to save a current configuration "**config save**" command is used.

Several commands can be grouped in one line using ";" character. If a wrong-syntax line is met in the group, the rest of the string is checked

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anyway and the wrong command is ignored. Command name can be shortened unless the ambiguity occurs.

If your terminal supports VT100 or ANSI standard you can move around the list of recently executed commands using cursor keys. Numbered list of these commands can be reviewed by "**!h**" command. Any command from this list can be available using "**!<NUMBER>**" command. TAB key performs substring search of recently executed commands.

Ctrl/R combination refreshes the command string if its content was disturbed by system messages.

The command executed with no arguments prints a short hint about its keys, parameters and syntax.

Context help can be obtained by printing "**?**" in any position of the line.

4. Lost password recovery

The system password can be recovered remotely. The procedure is the following:

1. Locate your device's serial number (SN)
2. Send this SN to the Altai Technical Support
3. You will be given a special key
4. Enter the device and use SN as a login and received key as a password
5. Reconfigure the username and password

Lost password recovery using Emergency Repair Console:

Recovery procedure can be done with the help of "*erp*" command or graphical "ERConsole" utility.

Below is a description of "ERConsole" utility recovery procedure ("*erp*" command recovery procedure is described in "OS WANFleX User Manual"):

1. Connect a computer and a device that should be repaired to one physical Ethernet segment.

It is recommended to put a switch between the unit and the PC from which ERConsole is executed.

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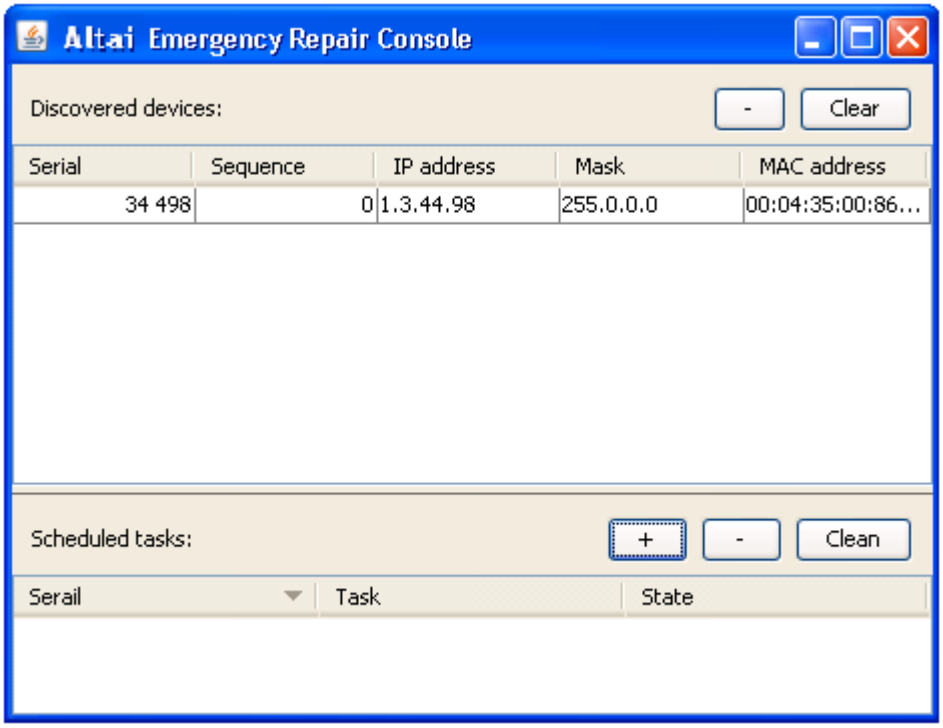
2. Start «ERConsole» utility on the computer by running "ERConsole.jar" file.

   Utility will be running in a waiting mode.

3. Restart the device. During its restart «ERConsole» utility will determine the device and will show necessary information about it in the "Discovered devices" section of the main window.



«ERConsole» utility main window.

4. Send "Serial" and "Sequence" field values to the Altai Technical Support.
5. You will be given a factory password for the device.
6. Press «+» button in the «Scheduled tasks» section of the main window.
7. In the opened "New task" window choose "Reset configuration" in the "Command" field. Then enter Serial number and factory password in the corresponding fields. Press «Ok».

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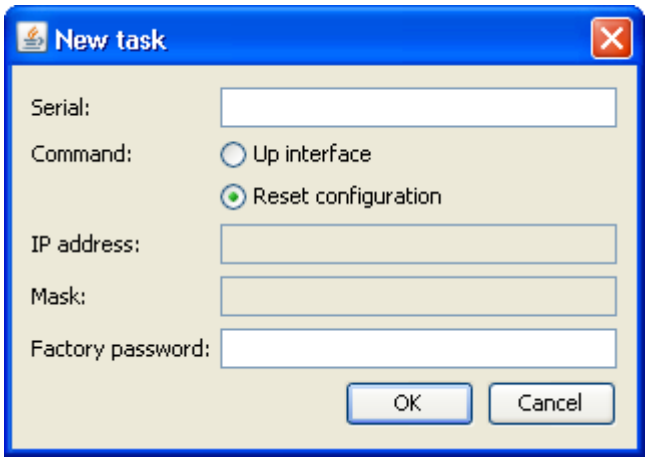

«New task» window.

8. Restart the device.

After device restart "ERConsole" utility will reset device configuration to the default.

9. Now login the device with any non-zero length login and password.

10. Reconfigure device username and password.

The "ERConsole" utility's "New task" window also allows setting the units' IP-address on its Ethernet interface (eth0) without login to the unit. To perform this procedure please follow the below steps:

1. Firstly, do steps 1-3 as described above.

2. Press «+» button in the «Scheduled tasks» section of the main window.

3. In the opened "New task" window choose "Up interface" in the "Command" field. Then type the required IP-address and network mask in the corresponding fields of the window and press "Ok" button.

4. Restart the device.

After the restart the "ERConsole" utility will add the IP-address into its Ethernet interface configuration and will up the interface (in case it was configured "down").

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5. Configuration manipulations

Printing and saving your configuration

You can easily review your current device's configuration by executing "**co**nfig **sh**ow" command. The output of the command is sorted by the configuration sections (e.g. "System parameters", "Interfaces configuration" etc).

You can review some particular parts of the configuration specifying the part of the configuration you want to see.

Example:

config **sh**ow ifc

This command will print the interfaces configuration. You can specify several parts of the configuration separating them with a space bar.

Example:

config **sh**ow rip nat

In order to save your configuration "**co**nfig **sa**ve" command is used. It saves the current system configuration in the Device's flash memory for subsequent permanent use. All modifications to the system parameters, if not saved by this command, are valid only during the current session (until the system reset occurs).

Import/export

Export/import of the device's configuration is performed using "**co**nfig **ex**port" and "**co**nfig **im**port" commands correspondingly. "**Co**nfig **ex**port" saves the Device configuration on a remote server and "**co**nfig **im**port" reloads it from a remote server. The information is transferred using FTP.

Example:

config **ex**port user:secret@192.168.1.1/var/conf/test.cfg

"Config import" command writes the uploaded file directly into the Flash memory without changing the active configuration in RAM. In order to make a new configuration active, right after **"config import"** command implementation finishes the device should be rebooted. If **"config save"** command is run before rebooting, Flash memory is

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overwritten by the copy of the active configuration. This action will erase the uploaded configuration file.

New firmware uploading

The latest firmware version can be downloaded from our support site http://www.altaitechnologies.com/partners_extranet.php.

Command "**flashnet**" uploads specified firmware version to the Device. Download is performed using FTP and FTP server should be installed somewhere in the network or on a local host from where download being performed.

File name is a full path including IP address of FTP server:

flashnet **get** upgrade@192.168.1.1/conf/altai/altai_new.bin

Where **192.168.1.1** is IP-address of FTP server and **.../conf/altai/altai_new.bin** is a full path to firmware version.

The download process has two phases:

- File uploading into RAM of Altai device.
- Programming Altai device flash memory from RAM firmware image. This phase is indicated by "O.O.O.O.O.O…" sequence.

Do not interrupt this process, otherwise device will be brought into invalid state and it recovery will be possible only at manufacturer premises.

During installation process all system events should be observed in the system journal (command **"sys log"**).

6. IP address formats

Many commands of the operating system require specification of IP addresses.

In OS WANFleX, the IP-addressees may be specified in traditional numeric format. Optionally, the mask may be specified either by its bit length (the specified number of leading bits in the mask are set to 1, the remaining bits are reset to 0) or numeric value. The IP address 0/0 denotes all possible IP addresses.

Therefore, the possible formats to specify IP-addresses are:

nn.nn.nn.nn (no mask is used)

nn.nn.nn.nn/N (N is the bit length of the mask)

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nn.nn.nn.nn:xxx.xxx.xxx.xxx (xxx.xxx.xxx.xxx is the numerical value of the mask)

Example:

The 192.168.9.0/24 address describes the network address 192.168.9.0 and the mask with leading 24 bits on.

The same set of addresses may be denoted as 192.168.9.0:255.255.255.0.

7. Ethernet interface configuration

In the most basic form Ethernet interface can be configured as follows:

ifconfig eth0 1.1.1.1/24 up

UP flag means than the interface is turned to UP state.

Also you can specify the following parameters for the Ethernet interface:

- Media type. By default media type is selected automatically (**media auto** parameter).
- Assign aliases to the Ethernet interface (**alias** key word)

Full information about interfaces configuration can be reviewed in OS WanFleX User Guide – **ifconfig** command.

8. Radio interface configuration

Radio interface configuration is performed using "**rfconfig**" command. In its most basic form one need to configure the following parameters of the radio interface:

- Frequency (**freq** parameter) in MHz. For example, 5260.
- Bit-rate (**bitr** parameter). Bit transfer rate in kBits/sec.
- System identifier (**SID** parameter). A hexadecimal number in the range of 1H to FFFFFFH. All Devices that are supposed to see each other on the same radio link must have the same identifier.

*Radio interface state is not saved in the configuration. That means that if you put radio interface to the **down** state after rebooting it will be in the **up** state.*

Example:

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rfconfig rf5.0 **freq** 5260 **bitr** 130000 **sid** 01010101

Additional important parameters and settings for the radio interface:

- **Rf5.0** – radio interface name in this case. In order to obtain radio interface name either see the ODU/Device labeling or execute "**ifc -a**" command.
- **txpwr** – transmitting power selection. Available power levels can be obtained using "**cap**abilities" parameter as shown above
- **burst** – enables burst mode. BURST protocol means grouping several short packets with the same destination address on a radio link into larger packets, thus cardinally decreasing the response time for applications generating streams of short packets. Burst enabling relates to a radio interface as a whole, and means only that you want to use this mode in this device; but the BURST protocol can only work for destinations where it is also enabled at the other end, and only if the MINT protocol is used at both sides.

  Burst enabling does not induce any changes in the work of other devices in the network. To disable "burst" mode use "**-burst**" parameter in "**rfconfig**" command.
- **distance**: this parameter is used to set the exact distance value between two devices (in kilometers). This parameter changes time values for some delays and time-outs of 802.11a/b/g protocol thus making possible to work on longer distances with smooth adjustment.

  There are several ways to manage this parameter:
  - if you set an exact value, this value is used no matter what the connection method is used
  - If the CPE has auto value instead of a number (by default), the CPE will configure its parameters using Base Station commands. It is enough to set a numeric value on a Base Station (the distance to the remotest CPE); all other CPEs will automatically adjust their work. While configuration showing, there might be the current distance value after **auto** parameter: **auto (XX)**
  - when knowing exact device's geographical coordinates (e.g. using GPS) you can specify their

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values in "**sys gpsxy**" command and distance parameter set as auto on all devices including the Base Station. In this case devices will automatically adjust their settings selecting an optimal value for the **distance** parameter. Base Station will calculate a distance to the remotest subscriber, and subscriber will calculate a distance to the base station. If the CPE has a link coordinates information it will use this information, otherwise it will use the **distance** parameter value got from the base station.

  - If **distance** parameter is set to 0 radio module will use default settings.

- **pwrctl –** automatic transmitting power control mode. In this mode the output power is set up automatically within the values available for the radio module. Used for CPE only.

Example:

rfconfig rf5.0 **freq** 5260 **bitr** 130000 **sid** 10203040 **burst**

rfconfig rf5.0 **txpwr** 18 **distance** auto

To learn your device's radio module capabilities type the command:

rfconfig <IF-NAME> **cap**abilitites

<IF-NAME> - radio interface name. Can be read on the device's labeling located on the case.

9. Wi-Fi AP interface configuration

Wi-Fi AP interface configuration is performed using "**wifi**" command.

To learn available Wi-Fi AP interfaces on your device (for example, wifi0) type the command:

ifconfig **-a**

Set proper IP address and net mask for Wi-Fi interface ("wifi0") using "ifconfig" command. For Wi-Fi AP activation use "*ifc wifi0 up*" command.

Example:

ifc wifi0 10.1.1.1/24

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ifc wifi0 up

wifi wifi0 **-freq** 2432 **–antenna** diversity

Available "wifi" command options:

ssid <"string"> - sets network ID (Service Set Identity).

-freq <value> - sets central frequency in MHZ.

-txpwr <value> - sets AP output power in dBm.

-antenna <value> - sets active antenna for AP. In *diversity* mode AP will choose antenna to use automatically for each subscriber depending on the link quality (only for APs with two Wi-Fi antennas).

-auth <string> - sets authentification type for subscriber connection.

-pass <"string"> - sets a password for subscriber authentification.

-wpa-encrypt <"string"> - sets traffic type for WPA-authentification.

Available "wifi" command parameters:

cap – shows AP capabilities.

status – shows AP status.

stations – shows AP's subscribers information.

10.Network topology setup

At the core of the system is a MINT (Mesh Interconnection Networking Technology) protocol which acts as a topology defining architecture of Altai system.

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V.Link Configuring

1. Preliminary decisions

Bitrate selection

Overall link performance is greatly depends on the right bitrate selection. Wrong bitrate of a radio link in most cases lowers its performance characteristics. In the result subscribers are getting bad services.

IW MINT architecture makes bitrate selection process fully automatic. Using IW proprietary Link Forecasting and Active Testing algorithms MINT chooses the optimal radio transmission rate individually for each connected subscriber device.

- Therefore, main recommendations for bitrate selection are: enable autobitrate mechanism and set the maximal available bitrate on the radio interfaces of all the devices
- To estimate the real bitrate of the device prior to its installation and deployment use the Range Calculator utility (see below).

Frequency planning for multi-sectored Base Stations

Base Stations with six sectors deliver the maximal performance by providing with sector reciprocal reservation and best price/performance parameter value. When having an optimal frequency gap of 40 MHz between adjacent sectors of the BS, the following schemes are recommended to be configured (e.g. having 5 available in configuration frequencies F1, F2 … F5):

- F1, F3, F5, F1, F3, F5
- F1, F3, F1, F3, F1, F3

Transmitting power selection

High output power correlates with the maximal connection performance. Decreasing the output power is logical when the maximal bitrate is already reached and there are no repeats. In this case excessive output power can decrease the system parameters. When having no built-in or external amplifiers one can try to install the automatic power control for the subscriber.

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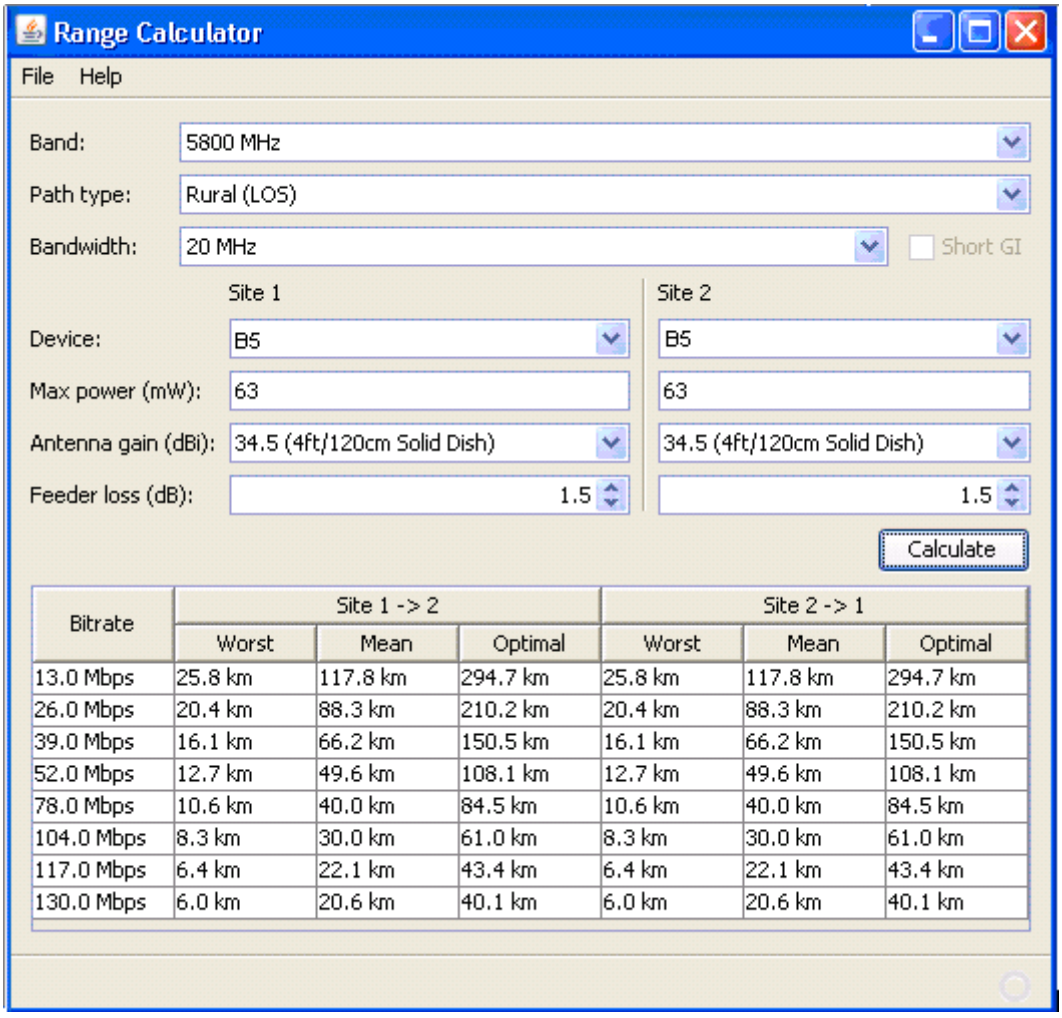
Range | Bitrate calculation

Range/Bitrate calculator allows estimation of a bitrate and distance for a particular radio link. This calculator can be downloaded from "Repository" of our web-site (http://www.altaitechnologies.com/partners_extranet.php).



Bitrate	Site 1 -> 2			Site 2 -> 1		
	Worst	Mean	Optimal	Worst	Mean	Optimal
13.0 Mbps	25.8 km	117.8 km	294.7 km	25.8 km	117.8 km	294.7 km
26.0 Mbps	20.4 km	88.3 km	210.2 km	20.4 km	88.3 km	210.2 km
39.0 Mbps	16.1 km	66.2 km	150.5 km	16.1 km	66.2 km	150.5 km
52.0 Mbps	12.7 km	49.6 km	108.1 km	12.7 km	49.6 km	108.1 km
78.0 Mbps	10.6 km	40.0 km	84.5 km	10.6 km	40.0 km	84.5 km
104.0 Mbps	8.3 km	30.0 km	61.0 km	8.3 km	30.0 km	61.0 km
117.0 Mbps	6.4 km	22.1 km	43.4 km	6.4 km	22.1 km	43.4 km
130.0 Mbps	6.0 km	20.6 km	40.1 km	6.0 km	20.6 km	40.1 km

Range/Bitrate calculator view.

To use the calculator:

1. Set needed frequency range in "Band" field.
2. Set NLOS parameters in "Path type" field.

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3. Set radio channel width in "Bandwidth" field.
4. For Site 1 and Site 2 define device model, device's max output, antenna gain and feeder loss.
5. Press "Calculate" button.

The results will be listed in a table below. For each available Bitrate value you will see corresponding distances in kilometers for "worst", "mean" and "optimal" environment conditions.

Earth surface relief is not taken into account in calculations.

2. Link diagnostic tools

Ltest

Ltest utility allows precise test of a radio link. It is recommended for antenna alignment when installing a new device or for testing of existing radio link.

Ltest can work in standard, alignment and bandwidth modes.

Standard mode:

In standard mode Ltest measures signal levels, retries, lost packets and acks.

To start Ltest in this mode:

lt rf5.0 <Mac-address of a device on the other side of the radio link>

When «**ltest**» command starts it will show you output information that contains testing results. You can see Ltest output below:

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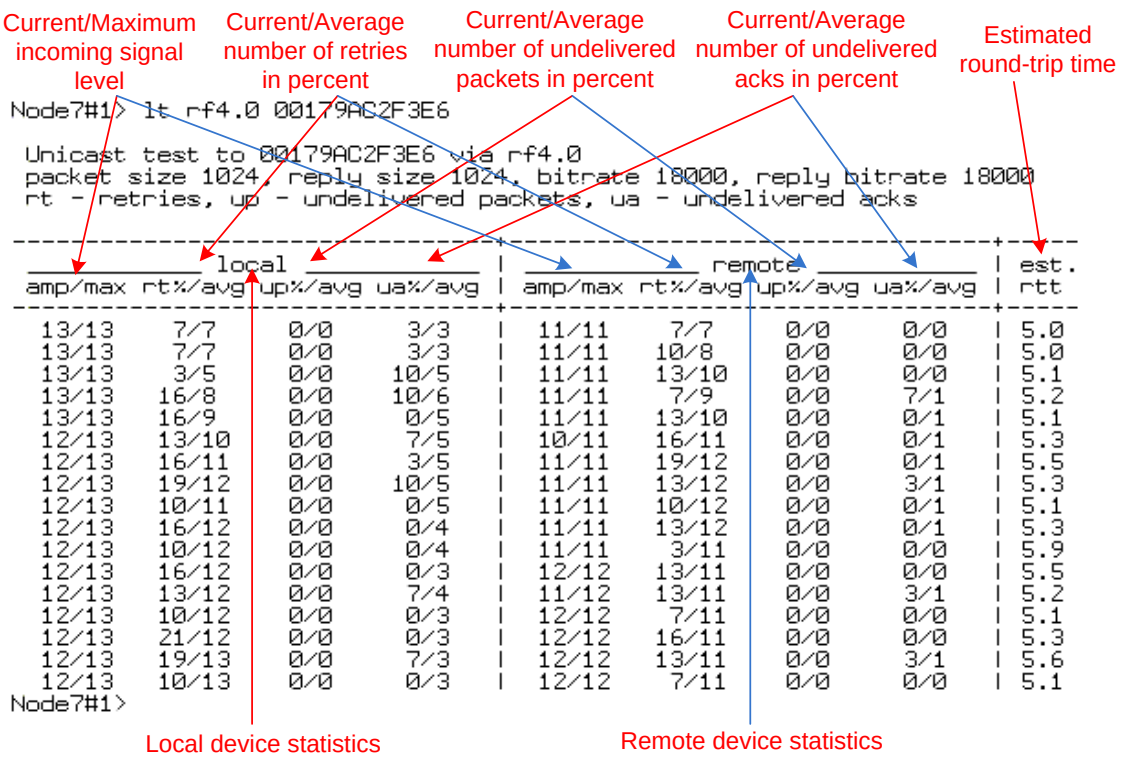

For success radio link establishing the following factors have to be considered:

1. It is recommended to start antenna alignment with searching maximum signal level on a minimal possible bitrate. Afterwards automatic MINT mechanisms will set the most appropriate bitrate if **autobitrate** mode will be enabled.

2. Current incoming signal level in «amp/max» columns (see "ltest" command output) must be between 12 and 40.

   When it is more than 40 it is recommended to lower amplifier power.

   If maximal signal level is less than 12 it is recommended to lower bitrate or channel width (for example, from 20MHz to 10MHz on the both sides of the radio link).
   In some cases signal level that is less than 12 may be enough for radio link operation. In this case one has to be guided by such parameters as number of retries, number of undelivered packets and number of undelivered acks. If the number of undelivered packets and the number of undelivered acks is null,

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the number of retries is small and all these parameters are constant in time then the radio link, most often, will be operating properly.

3. Number of retries value in «rt%» columns must be as close to zero as possible.

4. Number of undelivered packets value in «up%» columns must be zero; if this value is not zero then the radio link couldn't be exploited.

5. Number of undelivered acks value in «ua%» columns must be zero; if this value is not zero then the radio link couldn't be exploit. If this value is constantly not less then 50 then most probably «**distance**» parameter is set with a wrong value. If radio link distance is more than 20 km then «**long**» mode must be enabled.

ALL described parameters must be observed in the both (**Local** and **Remote**) sections of the «**ltest**» command output.

Alignment mode:

The difference of this mode from the standard one is that «ant.amps» column is used instead of «amp/max». «Ant.amps» column indicates signal levels for each of two antennas of a devce divided by ":" correspondingly.

To start Ltest in this mode:

lt rf5.0 <Mac-adress> -align [L,R]

Ltest output in alignment mode:

```
Unicast test to 000E8E1DF5E1 via rf5.0 with no priority
packet size 1024, reply size 1024, align, tx antennas: local(0), remote(1)
rt - retries, up - undelivered packets, ua - undelivered acks

-----------------------------------+-----------------------------------+-----
____________ local _____________ | ____________ remote _____________ | est.
ant.amps rt%/avg up%/avg ua%/avg | ant.amps rt%/avg up%/avg ua%/avg | rtt
-----------------------------------+-----------------------------------+-----
14:43:00   0/0     0/0     0/0   | 44:15:00   0/0     0/0     0/0   | 6.6
```

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Bandwidth mode (Bandwidth meter)**:**

Bandwidth meter is used to test the following radio link characteristics: throughput in kilobits per second, packets per second, number of retries and errors.

Use the following «*ltest*» command options for testing:

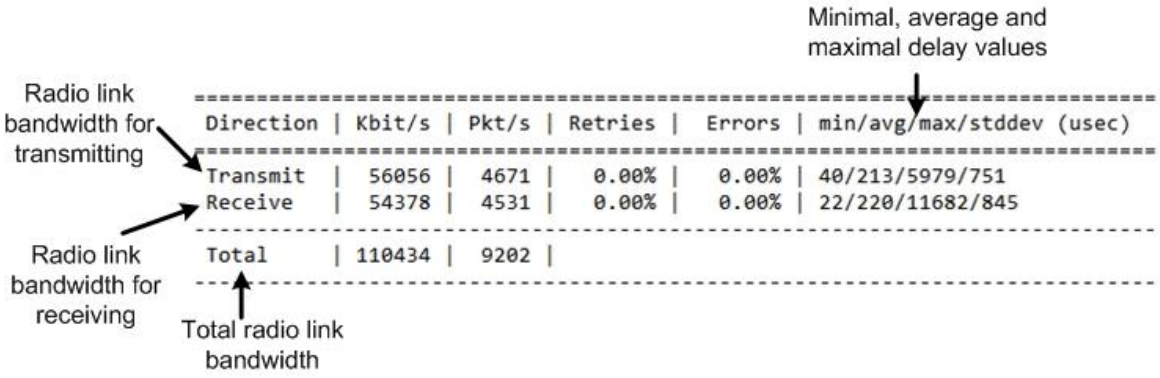
- **-tu [seconds]** – Unidirectional test: packets are transmitted only from the current side to the specified address ("*target*" option)
- **-tb [seconds]** – Bidirectional test: packets are transmitted in both directions

"*Seconds*" parameter allows setting test period (5 seconds by default). Maximum value is 60 seconds.

To start Ltest in this mode:

```
lt rf5.0 <Mac-adress> -tb
```

"Ltest" command output in Bandwidth meter mode:


Minimal, average and maximal delay values
Radio link bandwidth for transmitting
Radio link bandwidth for receiving
Total radio link bandwidth
Direction | Kbit/s | Pkt/s | Retries | Errors | min/avg/max/stddev (usec)
Transmit | 56056 | 4671 | 0.00% | 0.00% | 40/213/5979/751
Receive | 54378 | 4531 | 0.00% | 0.00% | 22/220/11682/845
Total | 110434 | 9202 |

Muffer

The **muffer** module makes it possible to rapidly test the electromagnetic environment, visually estimate the efficiency of the utilization of the air links, reveal sources of interference, and estimate their power.

Several operating regimes of the **muffer** module provide for different levels of details in test results

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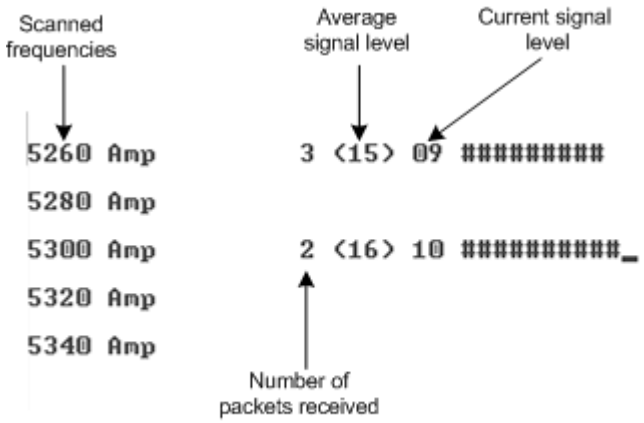
Review mode

This regime is enabled by the review option. It makes possible to have a general estimation of emissions and interference within specified frequency range.

Normal operation of the radio is not possible in this mode.

This regime can be useful on the first steps of link configuration. One can observe the activity on the selected list of frequencies and make decisions of what frequencies can be used for the link so that the link did not interfere with other sources of signals.

The scan is performed only for the packets corresponding with the standard of the radio module (802.11a for 5GHz devices and 802.11b for 2.4 GHz devices. Other sources of signals on the scanned frequencies stay unseen.



The picture above shows the output of **review** mode.

To run the **review** mode please type the following command:

muffer <IF-NAME> **rev**iew

Once the link is established you can use this mode to review the activity on the configured for frequency for the link. If no activity is observed that means that the signal from the remote side is being broken by the interference sources or by the obstacles on the signal propagation path.

MAC2 mode

This regime performs MAC-addresses analysis to estimate the number of clients with different MAC addresses and the efficiency of their

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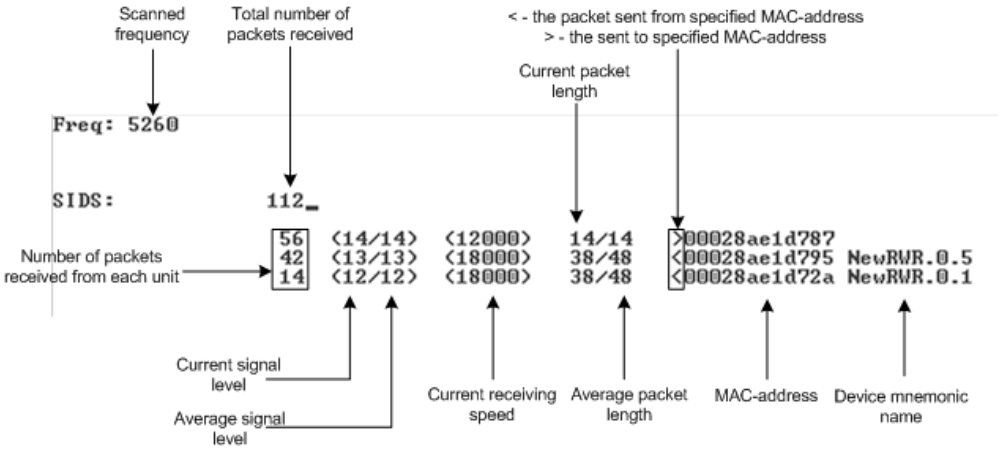
utilization of the air link. The analysis is carried out for all MAC addresses at the frequency previously specified by **rfconfig** command. The **mac2** regime checks both data packets and the link-level ACK messages sent by protocol supported devices.

Normal operation of the radio is not possible in this mode.

The picture below shows the output **mac2** regime.



Like in review mode this regime provides with the information about a current activity but on the configured frequency.

To run the **review** mode please type the following command:

muffer <IF-NAME> **mac2**

Statistics

The statistics gathering is used for estimating link load intensity and per client. The amount of packets sent and received, and the number of retransmissions is shown for each MAC address participating in the data exchange.

The statistics output is presented in the picture below.

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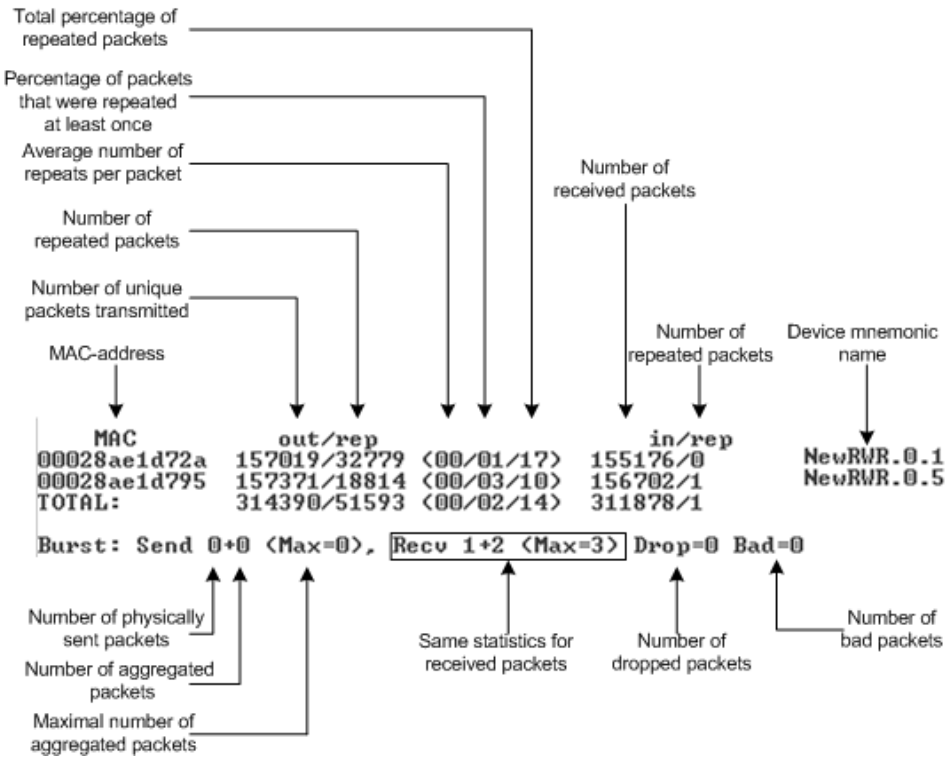
Total percentage of repeated packets
Percentage of packets that were repeated at least once
Average number of repeats per packet
Number of repeated packets
Number of unique packets transmitted
MAC-address
Number of received packets
Number of repeated packets
Device mnemonic name
MAC out/rep (00/01/17) in/rep
00028ae1d72a 157019/32779 155176/0 NewRWR.0.1
00028ae1d795 157371/18814 (00/03/10) 156702/1 NewRWR.0.5
TOTAL: 314390/51593 (00/02/14) 311878/1
Burst: Send 0+0 (Max=0), Recv 1+2 (Max=3) Drop=0 Bad=0
Number of physically sent packets
Number of aggregated packets
Maximal number of aggregated packets
Same statistics for received packets
Number of dropped packets
Number of bad packets

The following decisions can be made by analyzing the outputted parameters:

- If the number of repeated packets is comparable with total number of packets that means that you might have an interference source on the selected frequency. For normally operating link the percentage of repeated packets should not exceed 10%. It is extremely important to obtain a permanent zero value for the average number of repeats per packet. If the value is not zero that means that the link is NOT working properly and requires further improvement
- If total percentage of repeated packets and the percentage of packets that were repeated at least once are close to each other that might mean that you have got a permanent source of interference. Otherwise, it means that a strong interference source appears from time to time breaking your signal
- Concerning the fact that statistics module outputs the information for each MAC-address separately, you can reveal the problem for some specific unit on the wireless network

The "**muffer stat**" command shows the statistics only from registered devices.

To view **statistics** type the following command:

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muffer stat
To reset all counters please type
muffer stat clear

Other modes of muffer

The **muffer** also has the following modes:

- **mac** mode. Compared to the **mac2** mode this mode does not take link-level ACK messages sent by protocol support devices into account
- **mynet** mode performs the radio testing without disturbing radio module's normal operation, but taking into account only packets from within the given network
- **sid** mode. The **sid** regime allows estimating the number of currently operating subscriber groups having different identifiers (SID), and the efficiency of air links utilization. The analysis is carried out for all network identifiers at the frequency previously specified for the radio module by **rfconfig** command.

Load Meter

Load meter is a powerful tool that allows estimating the load of a system interface specified by interface parameter. By default, the information is displayed on one line and updated every second; the load is measured in kilobytes.

Below picture shows the load meter output for the radio interface outputted in line-by-line mode with one second interval.

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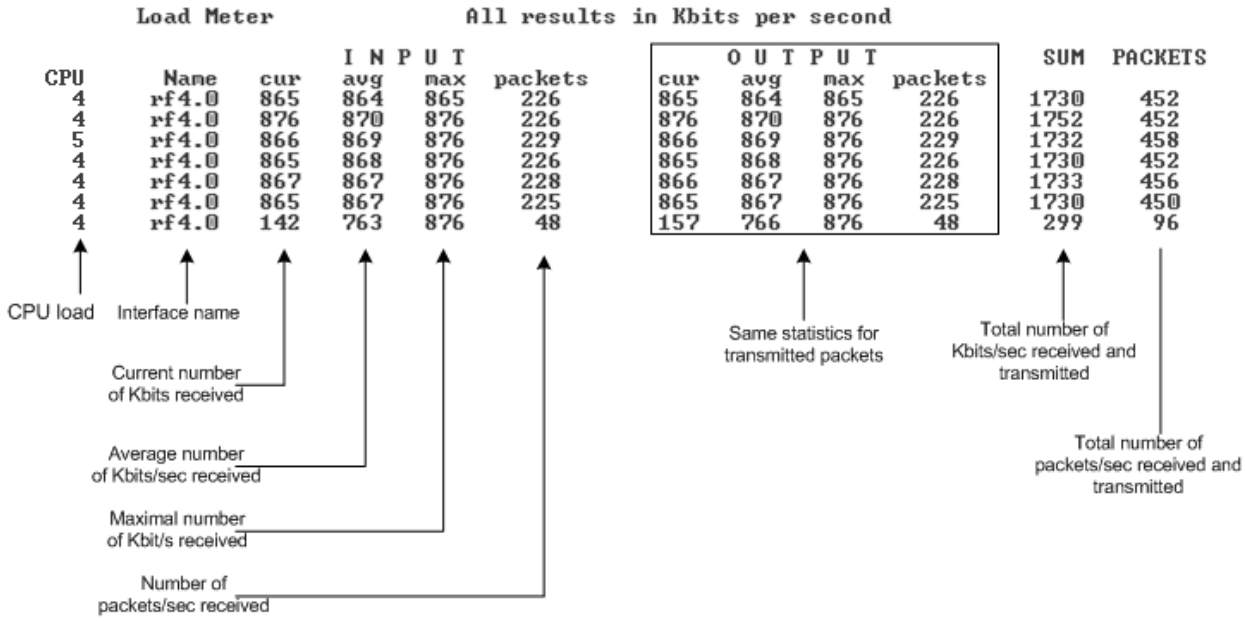

Load Meter
All results in Kbits per second
INPUT
OUTPUT
CPU Name cur avg max packets cur avg max packets SUM PACKETS
4 rf4.0 865 864 865 226 865 864 865 226 1730 452
4 rf4.0 876 870 876 226 876 870 876 226 1752 452
5 rf4.0 866 869 876 229 866 869 876 229 1732 458
4 rf4.0 865 868 876 226 865 868 876 226 1730 452
4 rf4.0 867 867 876 228 866 867 876 228 1733 456
4 rf4.0 865 867 876 225 865 867 876 225 1730 450
4 rf4.0 142 763 876 48 157 766 876 48 299 96
CPU load
Interface name
Current number of Kbits received
Average number of Kbits/sec received
Maximal number of Kbit/s received
Number of packets/sec received
Same statistics for transmitted packets
Total number of Kbits/sec received and transmitted
Total number of packets/sec received and transmitted

To run load meter like it is shown above, please type:

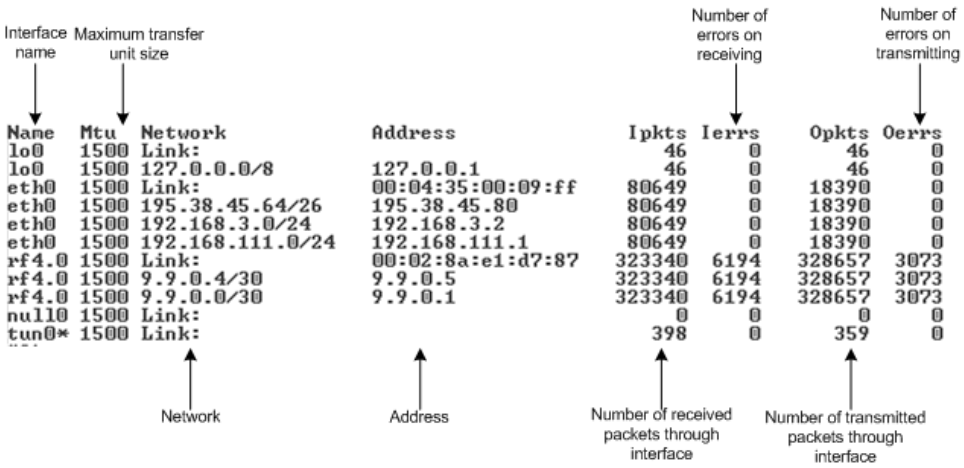
```
loadm –I <IF-NAME>
```

Acquiring interfaces statistics

Interface statistics can be acquired using **netstat** module which includes two modes:

- Routing tables output (using "**-r**" parameter with the command)
- Interfaces statistics output (using "**-i**" parameter with the command)

Below picture shows the example of interfaces statistics output.



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If the interface has several aliases the statistics is still measured for physical interface in a whole. For example, see rf5.0 or eth0 interfaces above. The numbers shown in 4 right columns correspond in physical interface.

Altai antenna alignment terminal

Altai antenna alignment terminal – is a special diagnostic device that is used for B5 comfort installation, antenna alignment and configuration.

Device allows getting the following information:

- Radio link establishment indication
- Visual monitoring of radio signal levels
- Receiving retries information
- Diagnostic of RF and Ethernet interfaces

Top view:

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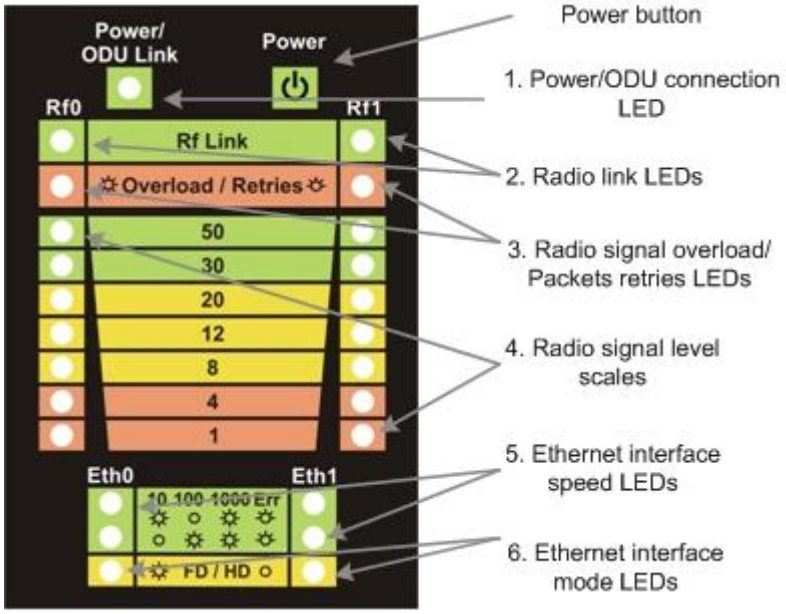
Back view:

Indicator panel:



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How to use:

Turning on:

1. For turning antenna alignment terminal-1 on simply push «Power button».
2. Device LEDs will light up for 2 seconds.
3. Device will perform constant tries to connect to ODU. If device's power is normal Power/ODU connection LED (1) will blink 1 time per second. If device's power is low LED 1 will blink 4 times per second in turn with not lighting intervals.
4. Once ODU link is established LED 1 stops blinking (if power is normal) and device's interfaces status are shown by LEDs 2-6.
5. 1 time per second device updates its status output.
6. If ODU link will be broken LEDs 2-6 will go out after 2 seconds and LED 1 will start blinking 1 time per second.

Diagnostic device connection to ODU should be done via console port of the ODU. Once link is up between ODU and diagnostic device the following record is put in ODU system log:

Connected test unit. Begin service communication over console.

Test unit detected: rf0 – rf5.0

Exact radio interface names depend on wireless equipment configuration.

When diagnostic device is unplugged from the following record is put in ODU system log:

Test unit disconnected. Return to normal console mode.

LEDs modes description:

ODU status monitoring via diagnostic device is performed by its LEDs indication. LEDs modes and ODU status correspondence is shown in the following table:

LEDs	Function
1. Power/ODU	Shows diagnostic device power status and diagnostic device-ODU connection status.

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connection LED	Constant lighting — diagnostic device-ODU connection established, diagnostic device power is normal. Blinking 1 time per second — diagnostic device power is normal, diagnostic device-ODU connection is not established. Blinking 4 times per second — diagnostic device-ODU connection established, diagnostic device power is low (change batteries). Frequent blinking with intervals — diagnostic device power is low, diagnostic device-ODU connection is not established.
2. Radio link LEDs	Show whether radio link is established on certain ODU's radio interface. Constant lighting — radio link is established. What ODU's radio interface to show by what column RF0 or RF1 is chosen by the following way: for RF0 column is taken radio interface with the least number, for RF1 the other interface. For example, there are the following radio interfaces on ODU: Rf5.0, rf5.1. Then for RF0 column rf5.0 will be taken, for RF1 — rf5.1. When no radio link then LEDs 2-4 are not lighting.
3. Radio signal overload/Packets retries LEDs	Show receiving radio signal level overload and number of packet retries information. Constant lighting —receiving radio signal level on the interface is too high. Blinking 4 times per second - number of retries >= 50% Blinking 2 times per second - number of retries >= 28 % Blinking 1 time per second - number of retries >= 7 % If certain radio interface (radio module) is not present on the device then all corresponding LEDs of this radio interface is off. If ODU has certain radio interface but it is not activated (for example, not entered «mint rf5.0 start» command) then LED 3 is blinking 1 time per second whereas LEDs 2 and 4 are not lighting. If ODU has certain radio interface but it is not activated (for example, not entered «mint rf5.0 start» command) then LED 3 is blinking 1 time per second whereas LEDs 2 and 4 are not lighting. If ODU has certain radio interface activated («mint rf5.0 start» command entered) then LED 3 is blinking 4 times per second whereas LEDs 2 and 4 are not lighting.
4. Radio signal level scales	Show receiving signal level of the established radio link. Each LED can be in 4 modes: Not lighting — radio signal level is lower than scale value. Blinking — the more frequently is blinking the nearer signal level is to given scale value. Constant lighting — signal level is higher or equal to scale value.

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<table>
<tr><td>5. Ethernet interface data rate LEDs</td><td>Show data rate of the corresponding Ethernet interface.

There are 2 LEDs for each Ethernet interface (Eth0 and Eth1).
<table>
<tr><td></td><td>10 Mbps</td><td>100 Mbps</td><td>1000 Mbps</td><td>Error</td></tr>
<tr><td>Upper LED</td><td>Lighting</td><td>Not lighting</td><td>Lighting</td><td>Blinking</td></tr>
<tr><td>Lower LED</td><td>Not lighting</td><td>Lighting</td><td>Lighting</td><td>Blinking</td></tr>
</table></td></tr>
<tr><td>6. Ethernet interface mode LEDs</td><td>Constant lighting — Full Duplex.
Not lighting — Half Duplex.

IF Ethernet connection is established but corresponding ODU's interface is not enabled then LEDs 5, 6 indicate connection configuration by blinking 1 time per second.</td></tr>
</table>

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VI. Configuration via Web-interface

1. Overall functionality overview

Web-interface is used for easy device management and monitoring via graphical web-based interface. Web-interface allows:

- Monitoring device interfaces statistics
- Monitoring radio link statistics
- Viewing and changing the device configuration
- Access graphical antenna alignment tool
- Running wireless link throughput tests
- Device maintenance and support
- Access to Spectrum Analyzer tool
- Viewing the system log
- DFS operation monitoring.

2. Run Requirements

In order to run and properly use the application, the following requirements must be met:

- Web-browser
- Latest OS WANFleX version
- Web-interface support activated on the device («webcfg start» command) - enabled by default

To connect to the device via Web-browser type: *http://<device IP-address>* (by default: ***http://192.168.1.20***).

You can also make an SSL-secured connection: *https://<device IP-address>* (by default: ***https://192.168.1.20***).

3. Localization

Web-interface has multiple language support including: English (default), Russian, Italian, French and Chinese.

The "Language" drop-down menu in the upper right corner of the Web-interface window enables setting the language for the current

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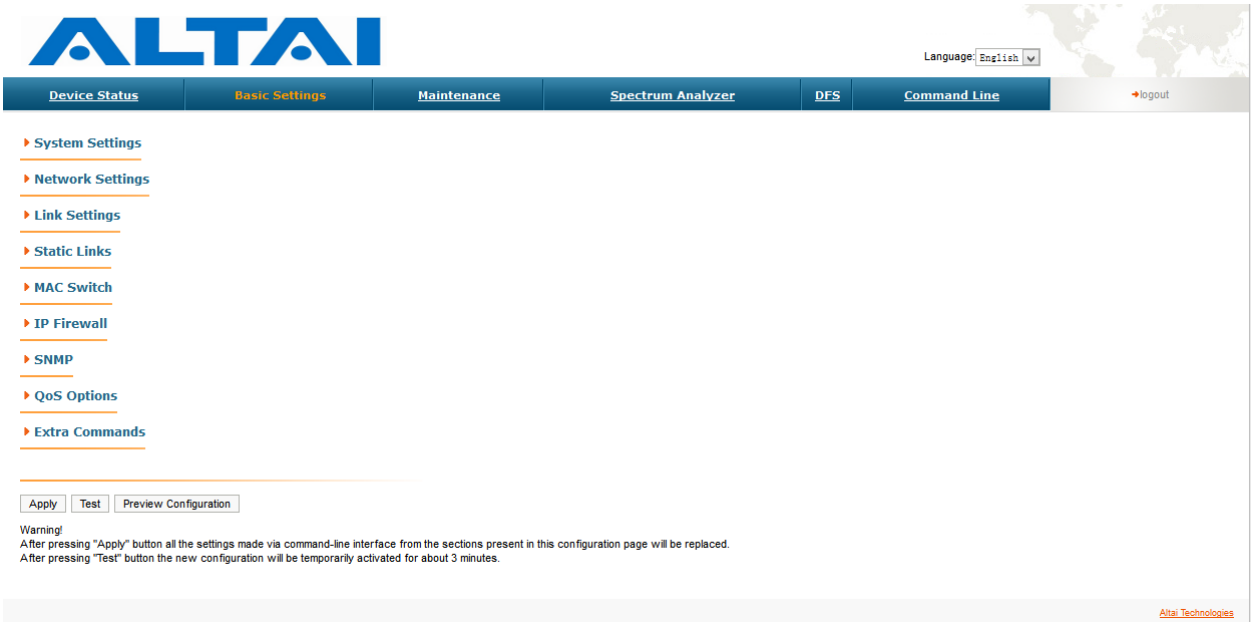
session only (the next time Web-interface will start with the default language).

To make the localization permanent please refer to the "System Settings" description in the "Basic Settings" section.

4. Basic settings



On the "Basic Settings" page the device configuration is performed. All the parameters that are available for configuration are divided into the dedicated sections (e.g. "System Settings", "Radio Settings").

To show/hide the parameters of the section just click on the section's header.

The listing and description of all the sections can be found below in this chapter.

To view the configuration that is done on the "Basic Settings" page in a CLI-based format, please use "Preview Configuration" button.

To apply the configuration changes to the unit use "Apply" button.

After pressing "Apply" button the unit's current configuration will be updated according to the parameters set on the "Basic Settings" page. The unit will be turned into the switch mode.

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"Test" button allows applying temporary configuration. The original (previous) configuration restores automatically after 3 minute period (180 seconds). The period can be extended and the changes can be either accepted or rejected immediately.

Description of the sections:

System Settings

This section allows viewing/setting system parameters of the unit's configuration:

- Device name – general device name
- User Name - user Name used as Login
- Password - secret password used to login into the unit
- Confirm Password - password confirmation
- Keep current system password – saves currently used password in the unit's configuration and locks "Password" and "Confirm Password" fields. In case this check-box is leaved unchecked and "Password" and "Confirm Password" fields are empty some web browsers may spontaneously put random data into them so that after the configuration is applied the password will be unknown to the user
- WEB Interface language – defines the language of WEB-interfaces (saves your language choice in the configuration and uses it in the next sessions from the start).

  To change the language of your current session only, please refer to the "Localization" section of the "Web-interface" chapter.

SNTP and Time Zone settings:

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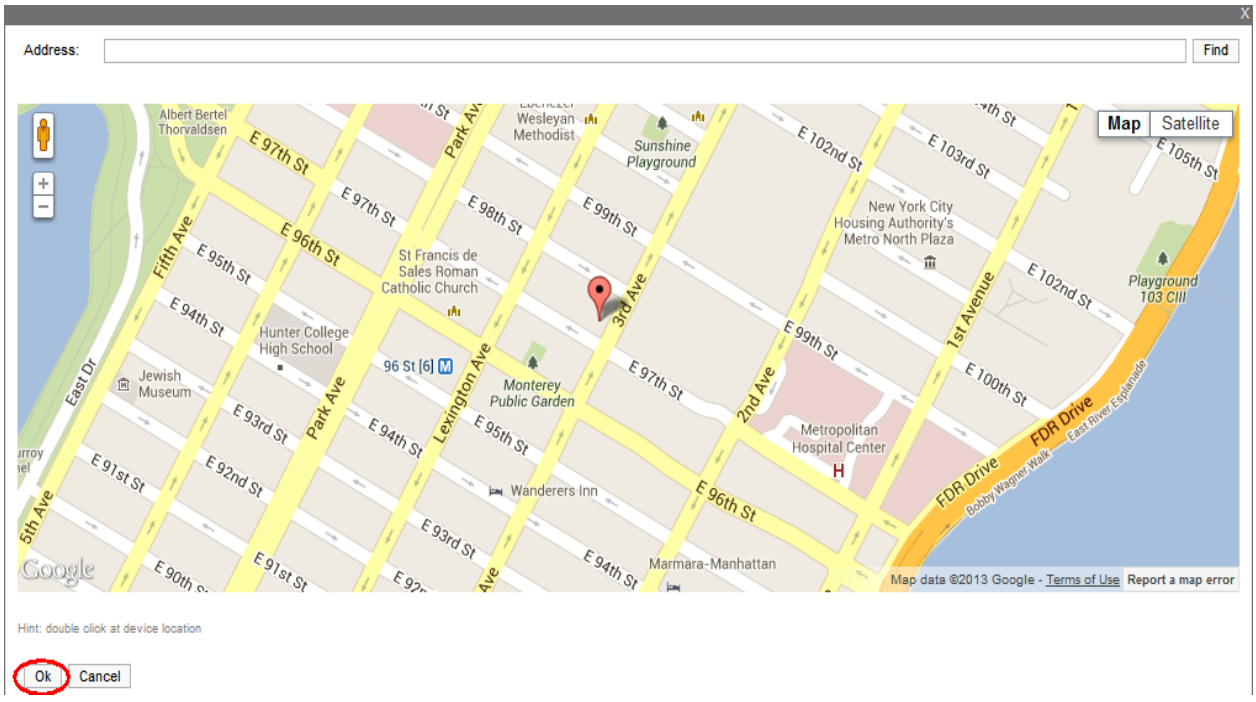
- Start SNTP – starts SNTP service
- SNTP IP Address - sets SNTP server IP-address
- Time Zone – sets Time Zone. For more details on time zones please visit: http://en.wikipedia.org/wiki/Time_zone.

- Latitude – type in the latitude of deployment location for unit, must begin with S or N. For example, " N 21.4812170 ";
- Longitude—type in the longitude of deployment location for unit, must begin with E or W. For example, " E 109.1198990 ";
- Open Map – after typing in the latitude and longitude of unit, click the "open map" then the matching location will be shown on a real google map. Below is an example for typing in "N40.786210" and "W73.948917". Or also can double click the real location on the map after open the map then click "ok", the latitude and longitude will be shown on the matching bar.



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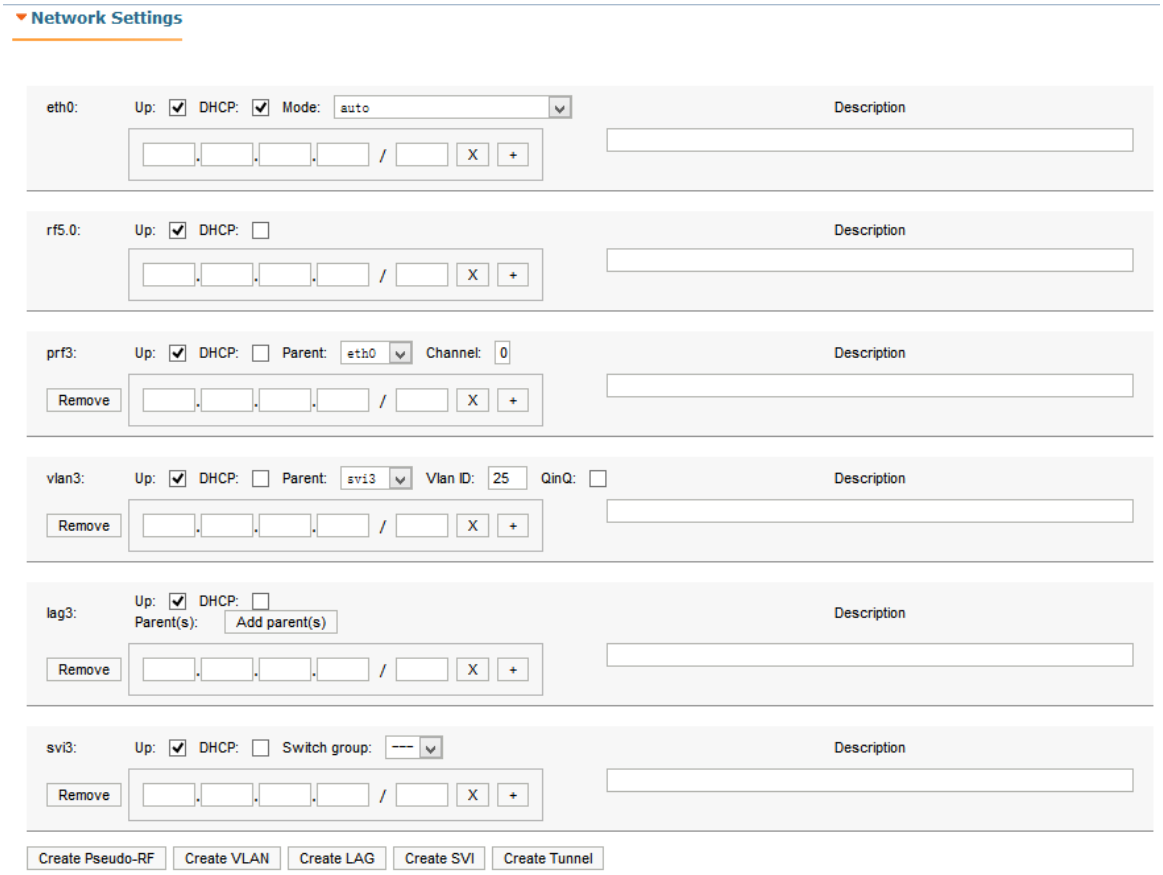
Network Settings



This section contains parameters related to network operation:

- ethX settings – Ethernet interface settings (e.g. eth0):
- Up enables/disables the interface
- DHCP allows DHCP client operation on the current interface
- Mode enables automatic or manual speed and duplex setup for the Ethernet interface. Recommended setting is Auto.
- IP-address field allows user to assign an IP-address to the Ethernet interfcace. Click the button to assign alias addresses or click X button to remove existing aliases.
- Description field can be used to add a text note to the interface config (up to 72 characters).
- rfX Settings - RF interface settings (e.g. rf5.0). Same as the Ethernet settings described above.
- prfX settings – Pseudo-RF interface settings (e.g. prf0):

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MINT network nodes can connect via either the wireless medium or a wired network. In order to establish connections via Ethernet PRF (Pseudo-RF) interfaces are used. A PRF interface makes the Ethernet interface that it's assigned to to appear as a regular RF interface in terms of the MINT network. For more information please refer to the Altai OS User Manual.

- General settings are the same as the Ethernet interface settings described above.
- Parent settings allow user to assign the PRF interface to the physical Ethernet interface.
- Channel setting can be used to set up several channel groups (0 – 4) inside the MINT network. Both PRF interfaces must have the same channel assigned in order for the link to be established.
- lagX settings – Link Aggregation interface settings (e.g. lag0):
- Link aggregation interface is a logical interface used to combine multiple physical channels into one logical channel in order to increase link capacity and redundancy.
- General settings are the same as the Ethernet interface settings described above.
- Add parent(s) functionallows user to add physical interfaces to the aggregated channel.

- vlanX settings – VLAN IEEE 802.1q settings (e.g. vlan0):
  - General settings are the same as the Ethernet interface settings described above.
  - Parent settings allow user to assign the VLAN interface to its parent interface.
  - VLAN ID field allows user to configure the VLAN tag for the current interface (1 – 4094)
  - QinQ checkbox enables dot1q tunneling on the interface.

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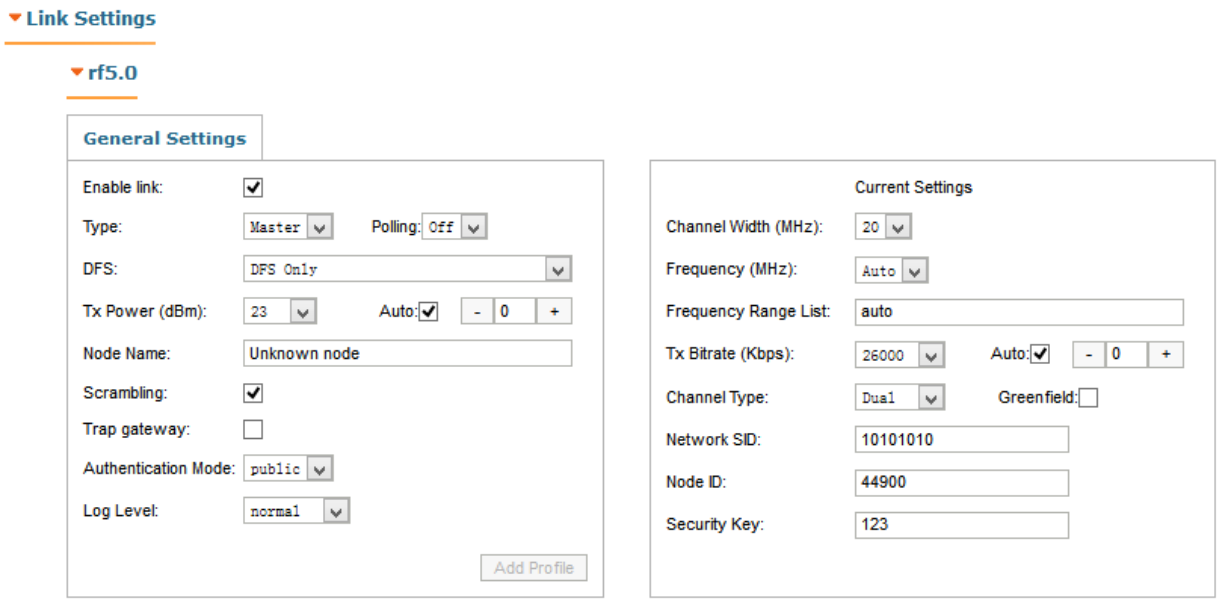
- sviX settings – Switch Virtual Interface settings:

An SVI interface is an L3-interface used to terminate or generate traffic in a certain switch group. Refer to the Altai OS manual for details.

  - General settings are the same as the Ethernet interface settings described above.
  - Switch group option allows user to bind the SVI interface to a switch group.

Default Gateway field is used to configure the default gateway used by the unit L3-interfaces to reach hosts on subnets different from its own. Create Pseudo-RF, Create VLAN, Create LAG and Create SVI buttons create the corresponding interfaces in the unit configuration.

Link Settings



This section describes all settings related to the RF link configuration

The Link Settings section is divided into two subsections: the panel on the left describes global link settings, the panel on the right describes radio channel settings that are currently in use.

The general settings panel contains the following items:

- Enable Link checkbox – enables/disables link operation

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- Type – each unit can be either a master or a slave in terms of the polling algorithm operation. Please note that each link requires only one master unit.
- Polling – enables/disables polling algorithm. It is strongly recommended to keep Polling on at all times to maximize link performance.
- DFS – DFS (Dynamic Frequency Selection) system operation mode:
    - DFS off – the DFS system is off. Please note that in some countries switching DFS off is against the regulations and may result in legal action.
    - DFS with radar detection – the DFS system performs radar detection. If a radar signal is detected the frequency is marked occupied and can be used again only after a hold-down interval. The link is switched to another frequency (provided there are available frequencies on the list).
    - DFS only – the DFS system monitors interferences but does not perform radar detection. Please note that in some countries failing to detect public service radar signals is against the regulations and may result in legal action.
- TX Power – configures transmitter power output. Enabling the ATPC (Automatic Transmitter Power Control) system is strongly recommended. The offset parameter is used to adjust the thresholds.
- Node Name – configures node name. This name will appear on the neighbor lists
- Trap gateway – enables/disables SNMP trap relay
- Authentication mode – configures the authentication mode used by the unit: public or static. Please refer to the Altai OS user manual, "Node Authentication" section, for more information.

The Current Settings panel contains the RF channel parameters:

- Channel Width (MHz) – RF link channel width in MHz.

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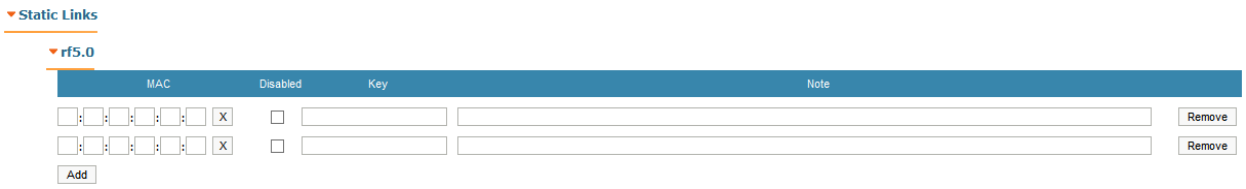
- Frequency (MHz) – central operating frequency in MHz.
- Frequency Range List – available only when the DFS system is enabled, this parameter allows users to list frequencies available for DFS operation.
- TX Bitrate (Kbps) – this setting controls the link bitrate. Enabling automatic bitrate selection is strongly recommended. The offset parameter is used to adjust the Auto bitrate system thresholds.
- Channel Type – selects channel mode:
- Dual – MIMO (recommended)
- Single – MISO
- The Greenfield checkbox enables/disables Greenfield mode. This feature optimizes the frames, transmitted via the RF link, boosting link performance by 10-15%.
- Network SID – Network System Identifier (up to 8-digit HEX figure). All units that belong to the same wireless network segment must have the same SID value.
- Node ID – the sequential number for the node. The parameter is optional.
- Security Key – a key word used to encode protocol messages. This key can be up to 64 characters long and should not contain spaces. All units that belong to the same wireless network segment must have the same Security Key.

Static Links



This section allows user to create a local nodes database. Please refer to the Nodes Authentication and Creating local nodes database sections of the Mint chapter of the Altai OS User Manual for more information.

Available settings are:

- MAC – defines the MAC-address of the allowed node.

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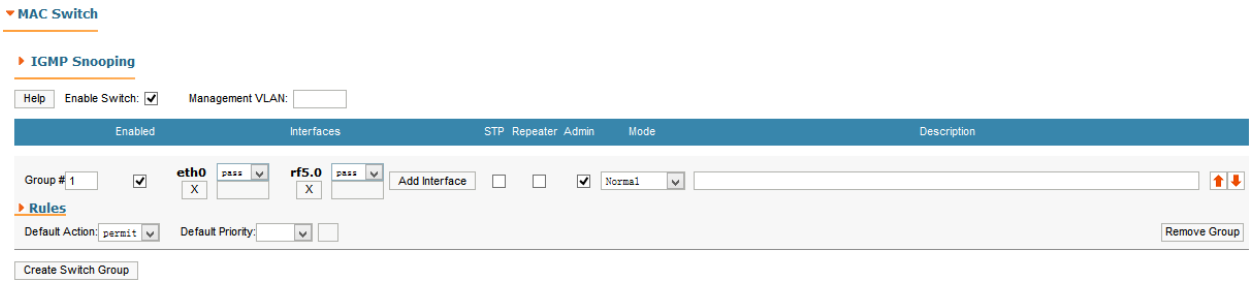
- Disabled – this checkbox temporarily disables the corresponding record in the database.
- Key –a unique key configured on the neighbor unit, can be up to 64 characters long, must not contain spaces. Refer to the Security Key paragraph in the previous section.
- Note – used to provide a short description.
- Remove – this button permanently removes the corresponding node from the database.

MAC Switch



This section allows stating the switch mode on the unit and creating multiple switch groups.

General section:

- "Help" button – displays general help guidelines for MAC switch configuration.
- "Enable Switch" check-box – starts switching on the unit
- Management VLAN – sets a Management VLAN ID. When set the device access and configuration are possible only via Management VLAN
- "Create Switch Group" button – creates a new switch group.

Group section:

- Group# - allows changing the unique numeric identifier of the group
- "Enabled" check-box - enables/disables the corresponding switching group

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- Interfaces – allows including local network interfaces of the unit ("ethX", "rfx", "tunX", etc.) into the switch group by selecting the corresponding check-boxes.

  Each local interface supports 3 modes of dealing with the VLAN tagged traffic going out from the interface:

  - Pass – transparent mode, i.e. in this mode all the traffic remains unchanged.
  - Strip – in this mode all VLAN tagged packets are untagged by the interface
  - Tag – in this mode all the packet are tagged with the VLAN tag specified in the field located below the "tag" option
- STP – enables Spanning Tree Protocol feature at the switching group
- IGMP – enables IGMP-Snooping feature at the switching group
- Repeater – starts the repeater mode. In this mode the group switches the packets simply by sending them to all the device's interfaces except the one the packet was received from.
- Admin – sets the switching group as the admin group. All the packets originated by the unit itself (e.g. RIP/OSPF or ping) leave the MINT network via the admin group. If "No Admin Group" is selected such packets isn't able to leave the network
- Mode – allows using one of the following switch group modes:
  - Normal – standard mode
  - Trunk – in this mode the packets are untagged and placed in groups with a number corresponding to the packet's VLAN TAG. (please see the full description of the trunk mode in Altai OS User Manual)
  - In-Trunk – this mode allows indicating to what trunk group belongs the group (please see the full description of the trunk mode in Altai OS User Manual)
  - Upstream – this mode is used for upstream multicast flows in video surveillance systems
  - Downstream – this mode is used for downstream traffic in video surveillance systems

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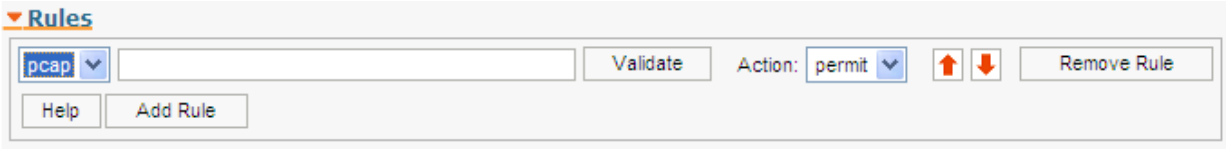
- Description - allows adding a text note to the group configuration
- Up and down arrows allows to change the group's order
- "Remove Group" button – deletes the group
- Group Rules – allows adding rules that defines what packets should be processed by the group
- Default Action – the action (permit or deny) taken on the packet if it doesn't match to any rule.

Rules



This subsection of the "MAC Switch" section allows adding rules that define what packets should be processed by the group.

- Pcap/vlan field – defines whether the rule is a PCAP expression or a VLAN list
- Rule field – a field where a rule shall be typed in. To view the rules help please use the "Help" button in the "MAC Switch" section (described above).
- Validate – checks if the rule typed in the "Match" field has the right syntax
- Action – the action (permit or deny) taken on the packet if it matches the rule
- Up and down arrows allows to change the rule's order
- "Remove Rule" button – deletes the rule
- "Add Rule" button – creates a new rule's entry in the "Group Rules" subsection.

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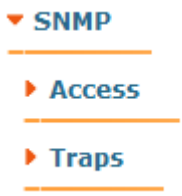
IP Firewall

IP Firewall is a mechanism of filtering packets crossing an IP network node, according to different criteria. You can find full information on IP Firewall in OS WANFleX User Manual.

This section allows creating of IP Firewall rules that determine which packets may be accepted/forwarded by the node.

- "Help" button – displays help guidelines for rules creation
- Direction – sets the rule as incoming (Input) or outgoing (Output). The incoming filters determine which packets may be accepted by the node. The outgoing filters determine which packets may be forwarded by the node as a result of routing
- Interface – specifies the logical interface of the unit which the rule will be applied to. If "any" option is used the rule will be applicable to all available interfaces
- Action – the action (permit or deny) taken on the packet if it matches the rule
- Log – enables registering filter actions in the system log
- Rule - a field where a rule shall be typed in
- Validate – checks if the rule typed in the "Rule" field has the right syntax
- Up and down arrows allows to change the rule's order
- "Remove Rule" button – deletes the rule
- "Add Rule" button – creates a new rule's entry.

SNMP



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This section allows managing SNMP (Simple Network Management Protocol) functionality.

Access

To enable SNMP functionality on the units and configure SNMP access parameters the "Access" subsection of the "SNMP" section is used. SNMP Versions 1 and 3 are supported.

To start SNMP services on the unit check the "Start SNMP" check-box.

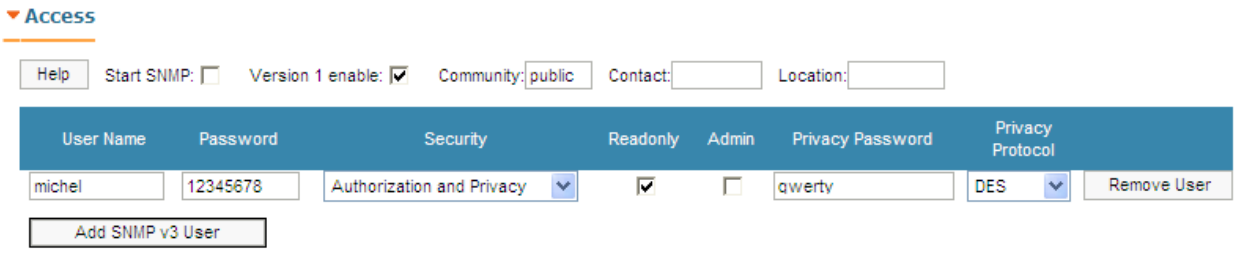
SNMP Version 1 Configuration:

The "Version 1 enable" check box enables/disables SNMP Version 1 support. The "Community" field sets a community name for the SNMP Version 1 agents. The default community name is "public".

The optional "Contact" and "Location" fields enable adding information about the unit's owner and location.

SNMP Version 3 Configuration:

To add a new SNMP Version 3 user press "Add SNMP v3 User" button. Then fill in the following parameters in the appeared fields:



- User Name – sets the SNMP Version 3 user's name.
- Password – sets the user's password for the authentification. Should contain at least 8 characters.
- Security – sets an SNMP Version 3 security level as follows:
    - No Authentification No Privacy – SNMP messages are sent unauthenticated and unencrypted.

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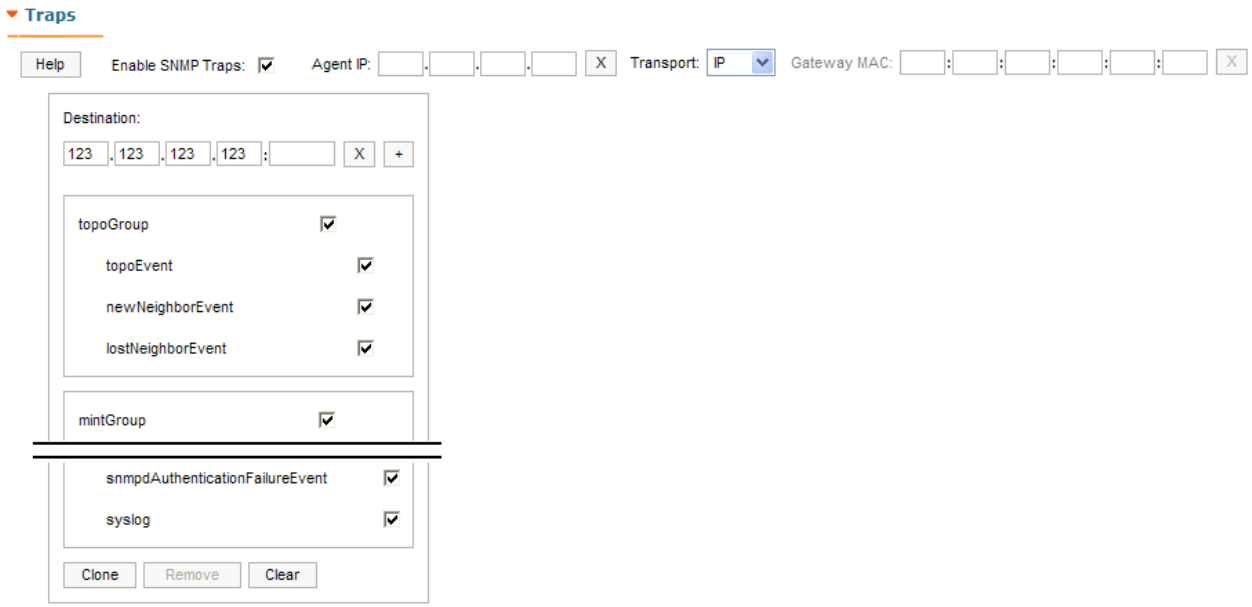
- Authentification No Privacy – SNMP messages are sent authenticated and unencrypted.
- Authentification and Privacy – SNMP messages are sent authenticated and encrypted. The passphrase for the encryption can be set in the "Privacy Password" field. The encryption protocol can be chosen in the "Privacy Protocol" drop-down field.

- "Readonly" check-box – if checked permits only to read the variables. If unchecked permits Read-Write operations.
- "Admin" check-box – if checked provides full access to the variables. If unchecked gives only limited access.
- "Remove User" button removes the user from the SNMP configuration.

Several users can be added to the SNMP configuration.

To display help on the SNMP configuration parameters use the "Help" button.

Traps



SNMP protocol enables a network agent to send asynchronous messages (traps) when some specific event occurs on the controlled device (object). Altai B5 units have a built-in SNMP Traps support module (agent) that performs a centralized information delivery from the unit's internal subsystems to the SNMP server. The SNMP Traps agent can be configured in this subsection.

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To start SNMP Trap agent on the unit check the "Enable SNMP Traps" check-box.

Available parameters:

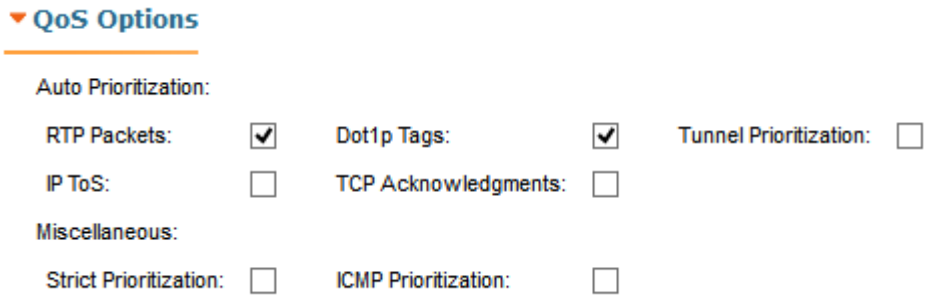
- Agent IP – agent's own IP-address sent with SNMP-trap packets
- Transport – transport method (IP or MINT Gateway). When "IP" is chosen SNMP-traps are sent to the SNMP server with the IP address specified in the "Destination" field.

  When "MINT Gateway" is chosen SNMP-traps is sent to the SNMP server via the SNMP network agent running on some other device (Gateway). To direct SNMP traps to the gateway type its MAC-address in the "Gateway MAC" field. If the "Gateway MAC" field is left blank SNMP traps are automatically sent to the defined MINT SNMP relay (to set the units as MINT SNMP relay use "Trap gateway" check-box in the "Link Settings" section).
- Destination - sets an SNMP server's IP-address and UDP port (port 162 is used by default). The below trap check-boxes defines the traps and the groups of traps to be sent to the server.

  The "Clone" button adds enables adding multiple SNMP servers.

  The "Clear" button unchecks all the trap check-boxes for the server.
- "Help" button – displays help on the SNMP Traps configuration parameters.

QoS Options



This section allows managing traffic prioritization.

"Auto Prioritization":

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This set of check-boxes allows enabling/disabling automatic traffic prioritization for different types of packets.

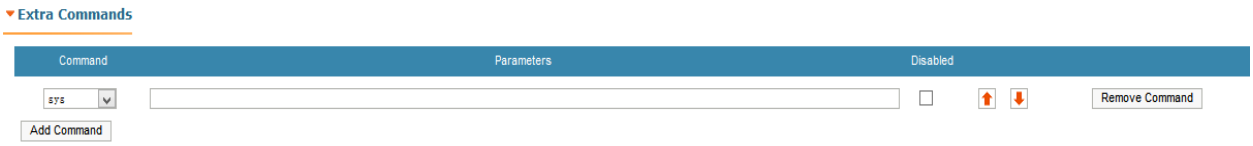
- RTP Packets – enables automatic prioritization for real time packets
- Dot1p Tags – enables automatic prioritization for packets labeled with IEEE 802.1p priority
- IP ToS - enables automatic prioritization for packets labeled with ToS
- TCP Acknowledgments – enables automatic prioritization for TCP Acks.

"Miscellaneous":

These options allow choosing the prioritization policy applied to the traffic queues and enabling ICMP prioritization.

- "Strict Prioritization" check-box enables "Strict Priority" prioritization policy (otherwise, by default, "Weighted Fair Queuing" policy is used).
- "ICMP Prioritization" check-box enables prioritization of ICMP (Internet Control Message Protocol) packets.

Extra Commands



The Extra commands section allows users to take advantage of the CLI configuration flexibility while keeping the web-interface as the main device management tool. While the web-interface is simple to use and understand, there are several parameters that can be configured via CLI only. However if any configuration changes are introduced via the web-interface later on, the configuration re-initializes and all CLI-configured parameters are reset to default. Use this section to add CLI-specific commands to the configuration in order to preserve the fine-tuning settings.

- Command menu – selects the command to add to the device configuration.

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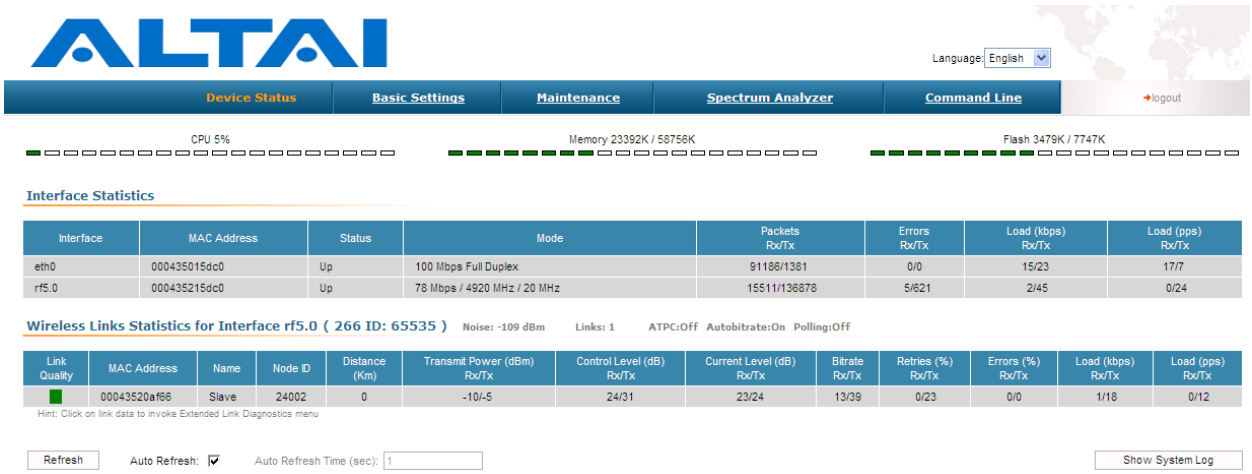
- Parameters – use this string to specify command parameters and options.
- Disabled – disables the command temporarily.
- Up/Down arrows – allow users to organize the command list
- Remove Command – deletes the command from the list permanently.
- Add command – adds the command to the list.

5. Device Status



The "Device Status" page allows viewing CPU/memory/flash usage and monitoring statistics of the unit's interfaces and radio wireless connections and using the graphical "Antenna alignment" tool and performing radio link performance tests and viewing the system log.

The "Interface Statistics" section displays the following parameters of all available interfaces of the device:

- Interface – the name of the interface
- MAC Address – the MAC-address of the interface
- Status – the status of the interface (Up, Down)

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- Mode – main working parameters currently used by the interface for its operation
- Packets Rx/Tx – the number of received/transmitted packets via the interface
- Errors Rx/Tx – the number of errors on the interface when receiving/transmitting
- Load (kbps) Rx/Tx – the data load of the interface in kilobits per second
- Load (pps) Rx/Tx – the data load of the interface in packets per second.

The "Wireless Links Statistics" section displays all neighboring devices which the interface (RF or Pseudo-RF) of the given node is connected to. The following radio link parameters are displayed:

- Link Quality – indicates the quality of the link to a neighboring device: green – the link has acceptable characteristics, yellow – the link has significant problems, red – the link has unsatisfactory characteristics.
- Neighbor – the neighbor's name
- MAC Address – the neighbor's MAC address
- Node ID – the sequential number of the neighboring node
- Distance – the distance of the link
- Transmit Power (dBm) Rx/Tx – transmit power values for remote/local sides of the link in dBm
- Control Level (dB) Rx/Tx – signal levels for receiving/transmitting (in dB) measured relative to the minimum possible bitrate
- Current Level (dB) Rx/Tx - signal levels for receiving/transmitting (in dB) measured relative to the Rx/Tx bitrates that are currently used for the link
- Bitrate Rx/Tx – the bitrates for receiving/transmitting that are currently used for the link
- Retries (%) Rx/Tx – measured percentage of the resent packets on the link for receiving/transmitting
- Errors (%) Rx/Tx – measured percentage of the errors on the link for receiving/transmitting

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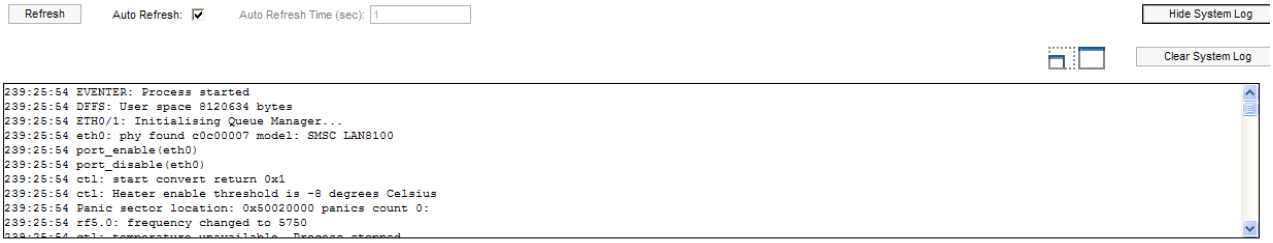
- Load (kbps) Rx/Tx – the data load of the link in kilobits per second
- Load (pps) Rx/Tx – the data load of the link in packets per second

The "Refresh" button updates the statistics.

The "Auto Refresh" check-box enables automatic statistics update. The update frequency (in seconds) can be set by the "Auto Refresh Time" parameter. The minimal possible value, "0" seconds, makes update process instant.

The "Show System Log" button shows the "System Log" section.


Refresh
Auto Refresh:
Auto Refresh Time (sec):
1
Hide System Log
Clear System Log
239:25:54 EVENTER: Process started
239:25:54 DFFS: User space 8120634 bytes
239:25:54 ETH0/1: Initialising Queue Manager...
239:25:54 eth0: phy found c0c00007 model: SMSC LAN8100
239:25:54 port_enable(eth0)
239:25:54 port_disable(eth0)
239:25:54 ctl: start convert return 0x1
239:25:54 ctl: Heater enable threshold is -8 degrees Celsius
239:25:54 Panic sector location: 0x50020000 panics count 0:
239:25:54 rf5.0: frequency changed to 5750

The "System Log" section allows browsing the unit's system log. It is possible to minimize/enlarge the system log window with the following buttons: .

The "Clear System Log" button deletes all the information from the system log.

To hide the "System Log" section press "Hide System Log" button.

Extended Link Diagnostic

Once the unit is wirelessly connected to the remote neighbor it is possible to make extended diagnostic and optimization of this link. To do this just mouse-click on the row containing the data of the wireless link you want to test (see the picture below):

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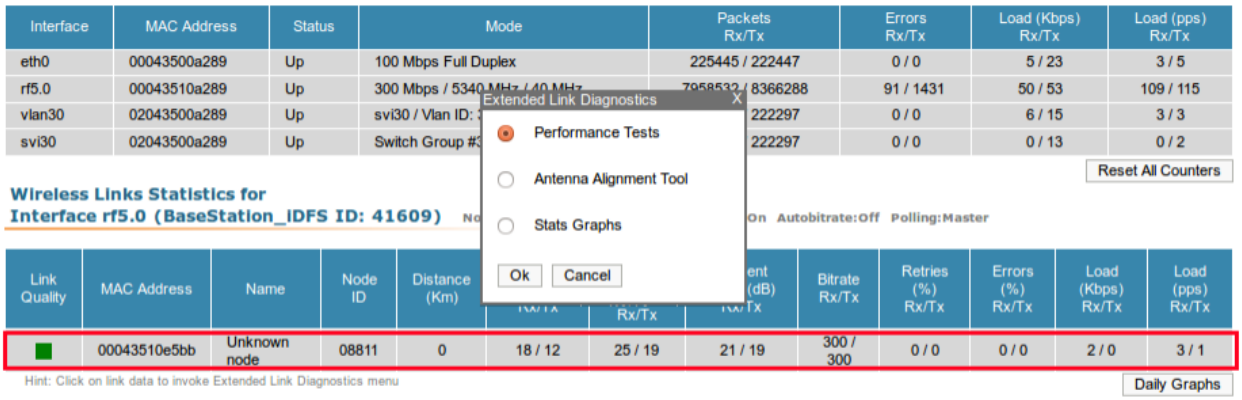
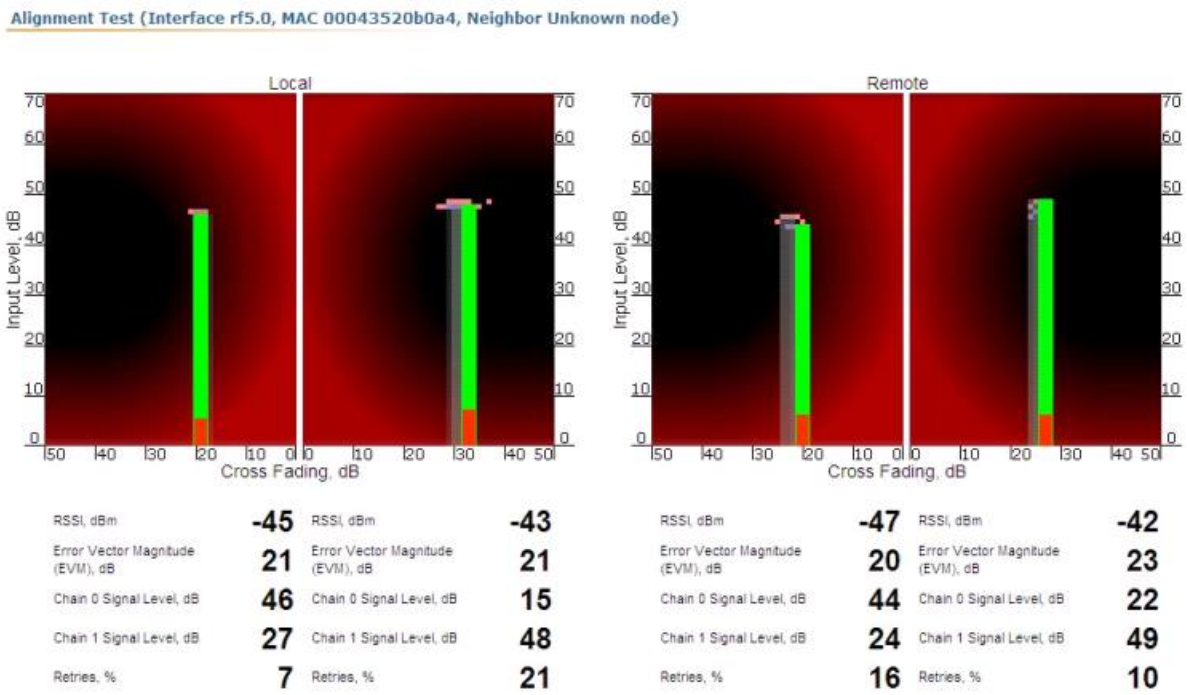


Then choose "Antenna alignment tool" or "Performance tests" from the appeared "Extended Link Diagnostic" window.

Antenna alignment tool

Graphical antenna alignment tool visualize antenna alignment process making it quicker, easier and comfortable for the user.

"Antenna alignment tool" page view for B5 device models is shown below:


Alignment Test (Interface rf5.0, MAC 00043520b0a4, Neighbor Unknown node)
Local
Remote
Input Level, dB
Cross Fading, dB
RSSI, dBm -45 RSSI, dBm -43
Error Vector Magnitude (EVM), dB 21 Error Vector Magnitude (EVM), dB 21
Chain 0 Signal Level, dB 46 Chain 0 Signal Level, dB 15
Chain 1 Signal Level, dB 27 Chain 1 Signal Level, dB 48
Retries, % 7 Retries, % 21
RSSI, dBm -47 RSSI, dBm -42
Error Vector Magnitude (EVM), dB 20 Error Vector Magnitude (EVM), dB 23
Chain 0 Signal Level, dB 44 Chain 0 Signal Level, dB 22
Chain 1 Signal Level, dB 24 Chain 1 Signal Level, dB 49
Retries, % 16 Retries, % 10

"Start Test"/"Stop Test" buttons at the bottom of the page start/stop the alignment test.

"Exit Test" button returns to the "Device Status" page.

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"Help" button displays help guidelines for antenna alignment.

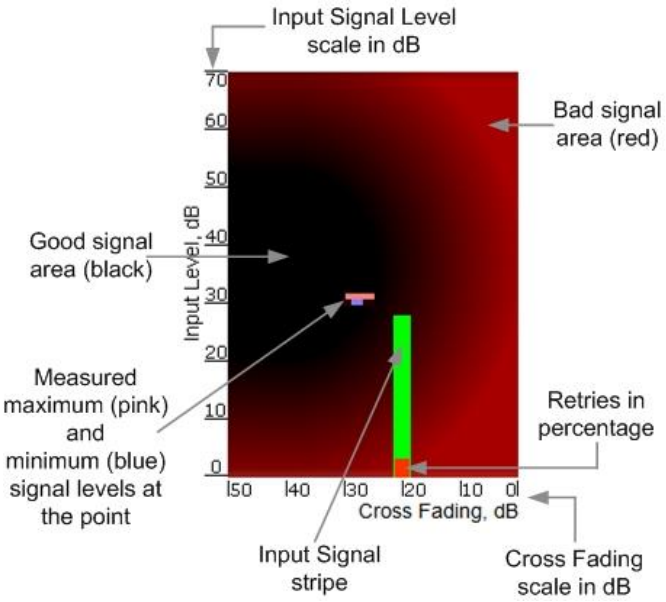
Once the test is started antenna alignment can be monitored using graphical and text indicators. Indicators for both local and remote devices are displayed together on the same page that allows viewing the alignment process for both sides of the link.

Each side of the link (local and remote) has two similar test indicator sets corresponding to two antenna polarizations (rx chains) of the device (one for Vertical polarization and another for Horizontal). This allows controlling the alignment process for each antenna polarizations for local and remote devices simultaneously.

Text indicators are the following:

- RSSI, dBm – RSSI indicator of the input signal. Measured in dBm.
- Error Vector Magnitude (EVM) – indicator of the measured input signal quality. It should be as high as possible. The recommended level is not less than 21.
- Chain 0 Signal Level – input signal level indicator of antenna number 0 (vertical polarization).
- Chain 1 Signal Level – input signal level indicator of antenna number 1 (horizontal polarization).
- Retries – percentage of transmit packet retries.

Graphical indicator:



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The main item in the graphical indicator is Input Signal stripe.

The height of the Input Signal stripe is measured by Input Signal Level scale in dB. The higher is the stripe the stronger is the signal.

The stripe can change it location along the Cross Fading scale that shows how much influence the corresponding device antenna has on the other one, i.e. how much vertically and horizontally polarized signals influence each other. The higher value has the stripe according to the Cross Fading scale (the farther stripe is from the 0 dB value) the less influence antennas have on each other.

The top of the Input Signal stripe can be located in black (Good signal) or red (Bad signal) background areas or somewhere in washed border between them. It means the signal is good, bad or average correspondingly. When aligning the antenna it is recommended to try to achieve the stripe top to be located in the black area.

At the bottom of the Input Signal stripe may appear a special red sub-stripe. This sub-stripe indicates the presence of packet retries and its percentage of the total transmitted packets number.

During alignment test the Input Signal stripe may be moving along Cross Fading scale and increase or decrease in height indicating the changes in the received signal. When the top of the stripe is changing its location moving from one point on the background area to the other it commonly leaves pink and blue marks that indicate measured maximum and minimum levels of the signal at the particular point. Thus it makes possible to observe the "history" of the signal changes. To clear the marks use "Clear History" button at the bottom of the page.

Main recommendations when using "Antenna alignment tool":

1. It is recommended to start antenna alignment with searching maximum signal level on a minimal possible bitrate. Afterwards automatic MINT mechanisms will set the most appropriate bitrate when **"Autobitrate"** mode will be enabled.
2. Input signal level should be between 12 and 50. ATPC is recommended to be enabled.

   If signal level it is more than 50 it is recommended to lower amplifier power (ATPC will do it automatically).

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If maximal signal level is less than 12 it is recommended to lower channel width (for example, from 20MHz to 10MHz).

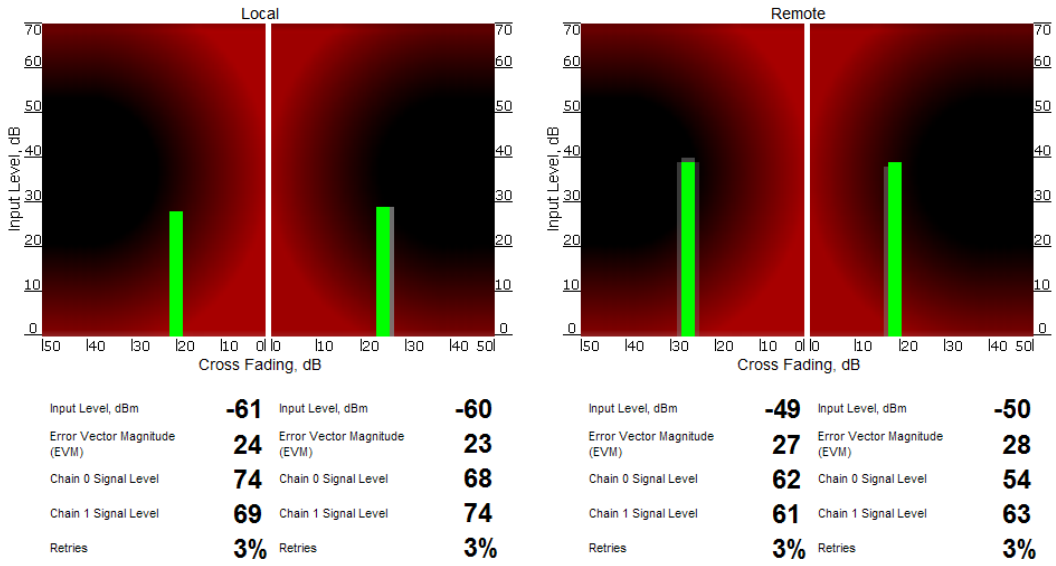
In some cases signal level that is less than 12 may be enough for radio link operation. In this case one has to be guided by such parameters as number of retries and Error Vector Magnitude. If the number of retries is small and EVM is more than 21 (Input Signal stripe is green) then the radio link, most often, will be operating properly.

3. Retries value should be zero or as low as possible.
4. The top of an Input Signal stripe should be located in the black area.
5. The signal quality should be good: EVM value should be more than 21.
6. Input signals of the two antennas of the device should have similar Cross fading values (Input Signal stripes should be located symmetrically relating to the 0 dB value).

ALL described recommendations are applicable to both (Local and Remote) sections.

Link samples:

- Good link sample



- Bad link sample

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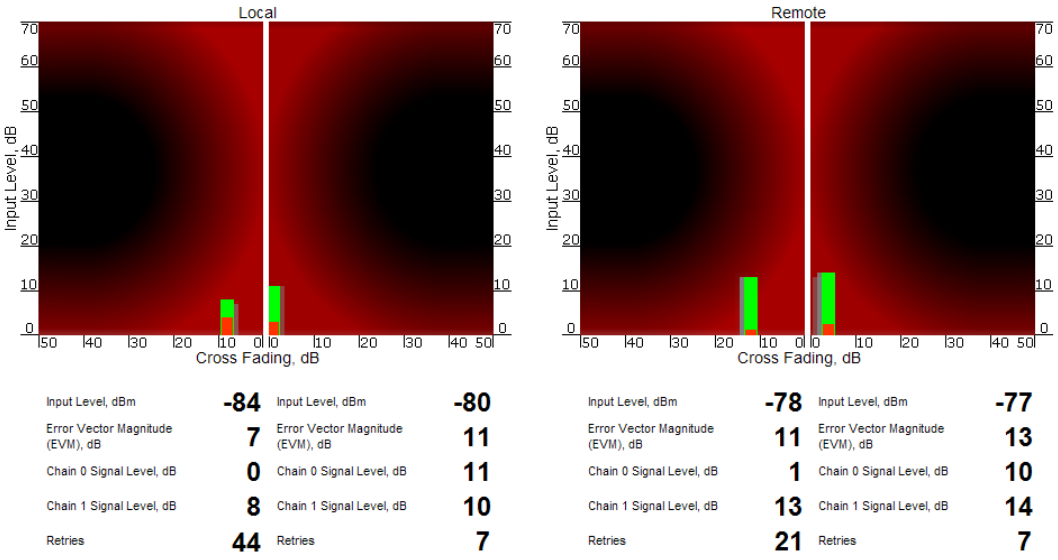

Input Level, dBm	-84	Input Level, dBm	-80
Error Vector Magnitude (EVM), dB	7	Error Vector Magnitude (EVM), dB	11
Chain 0 Signal Level, dB	0	Chain 0 Signal Level, dB	11
Chain 1 Signal Level, dB	8	Chain 1 Signal Level, dB	10
Retries	44	Retries	7

Input Level, dBm	-78	Input Level, dBm	-77
Error Vector Magnitude (EVM), dB	11	Error Vector Magnitude (EVM), dB	13
Chain 0 Signal Level, dB	1	Chain 0 Signal Level, dB	10
Chain 1 Signal Level, dB	13	Chain 1 Signal Level, dB	14
Retries	21	Retries	7

Performance tests

The "Performance tests" page allows performing link throughput tests on all the bitrates that are available for the configured channel bandwidth.

"Performance tests" page view is shown below:

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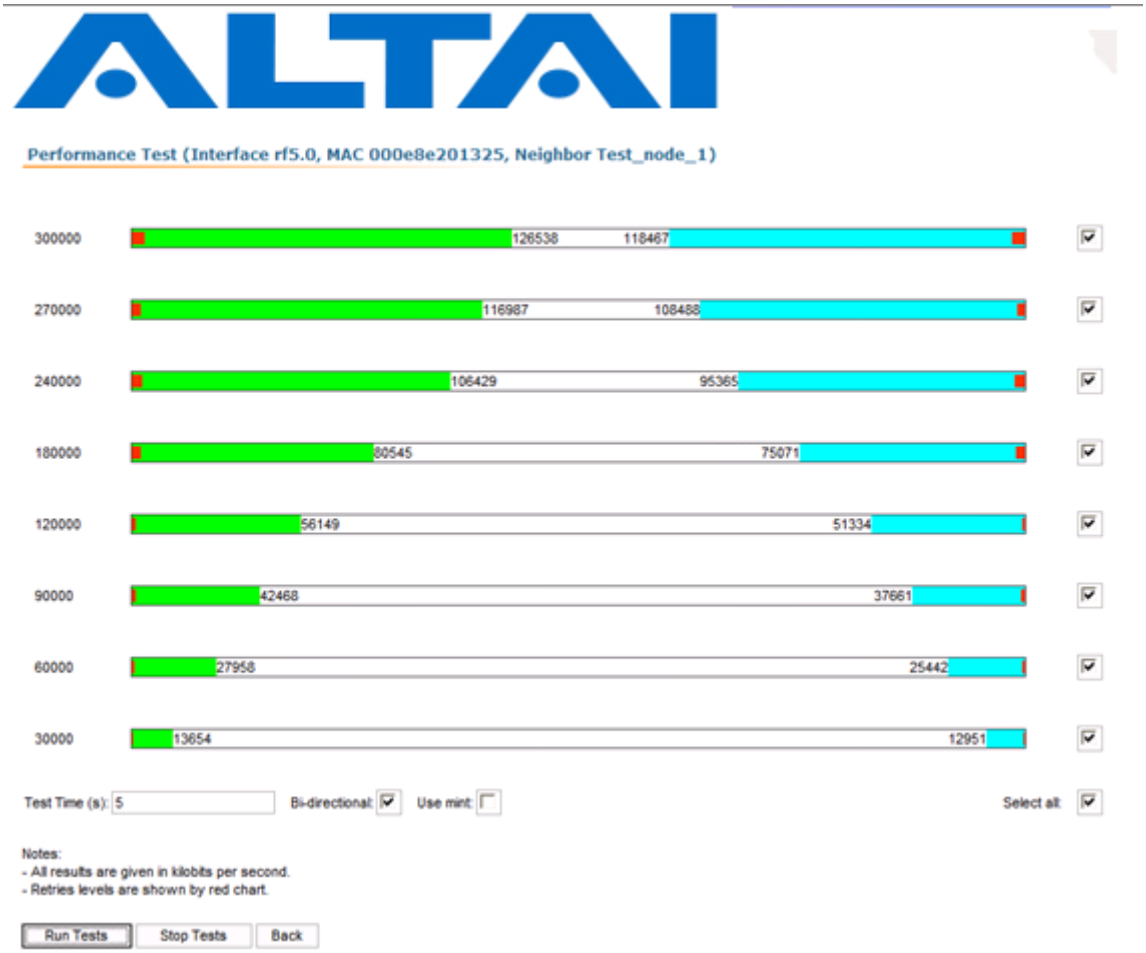

"Run Tests"/"Stop Tests" buttons at the bottom of the page start/stop the performance tests.

"Back" button returns to the "Device Status" page.

Each row corresponding to a certain bitrate value can be selected or deselected for participating in the performance test by using a check-box on the right of it. By using "Select all" check-box all the bitrates could be selected/deselected at once.

Three more parameters are available for management:

- "Bi-directional" check-box that allows choosing between making bi-directional (when checked) and unidirectional (unchecked) performance tests.
- "Use mint" check-box allows performing MINT-enabled test when all the traffic and link parameters are controlled and managed by MINT functions such as ATPC and autobitrate. In this mode the statistics for errors abd retries is not available.

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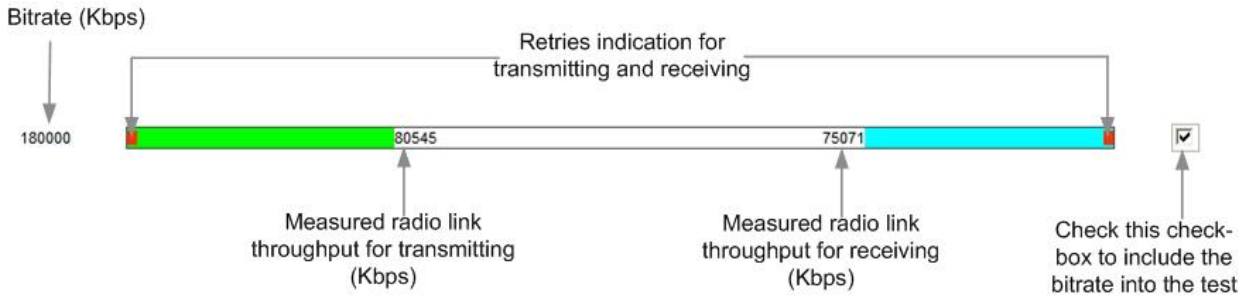
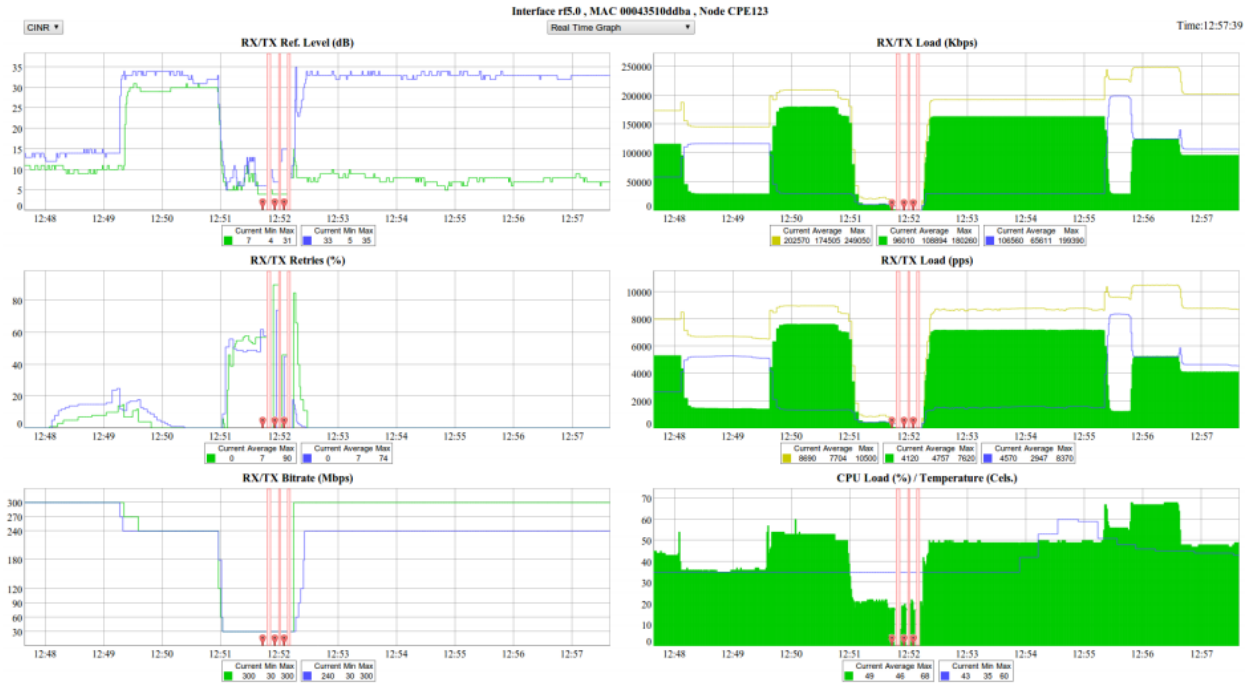
- "Test time" parameter allows setting the duration of the test for each bitrate in seconds (5 seconds by default).

The bitrates list on the "Performance test" page consists of the bitrates that corresponds to the channel bandwidth set on the unit (5/10/20/40MHz). To perform the tests for the bitrates related to the other channel bandwidth you need to reconfigure channel bandwidth ("Channel Width" parameter in the "Radio Setting" section of the "Basic Settings" page) on both units that form the tested link.

Bi-directional performance test output description for 180 Mbps bitrate (40MHz channel bandwidth):


Bitrate (Kbps)
Retries indication for transmitting and receiving
180000
80545
75071
Measured radio link throughput for transmitting (Kbps)
Measured radio link throughput for receiving (Kbps)
Check this check-box to include the bitrate into the test

This tool allows users to monitor device parameters represented as colorful graphical charts. Supported modes are real-time monitoring and daily data logs display.



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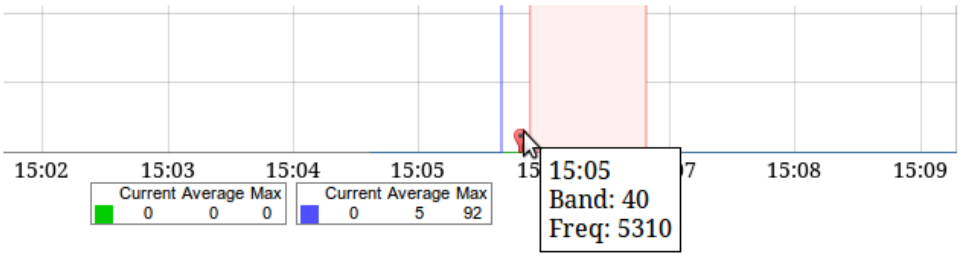
By default the system displays daily data logs. All charts support simultaneous zooming to improve usability: once the user zooms into a certain region on any of the charts, all other charts are re-scaled automatically to display the data collected during the same period of time. Critical events like link outages or frequency swaps are marked by small red balloons on the bottom of each graph. Hover over each balloon for details.

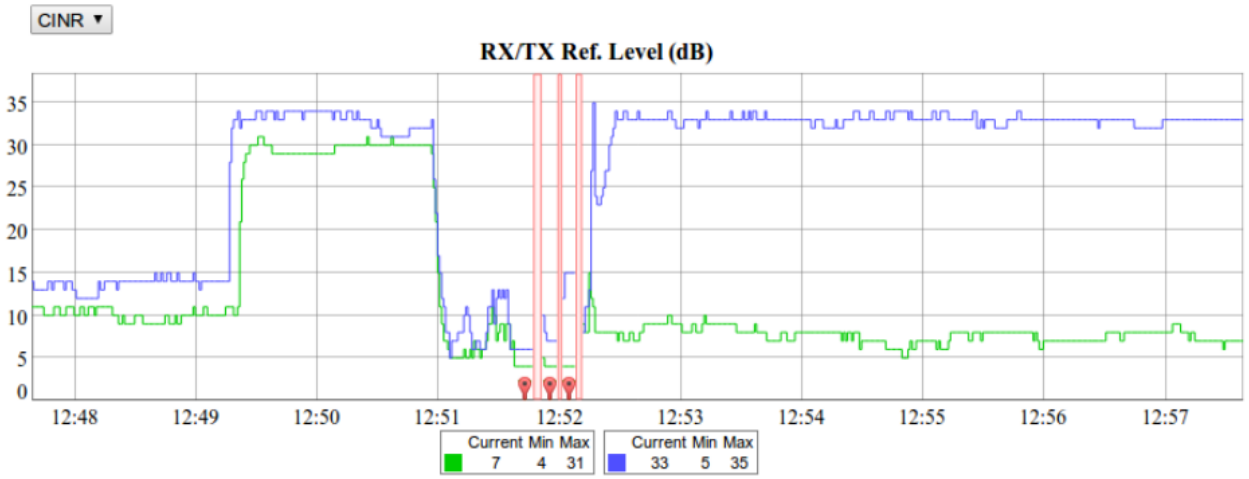


Working with the charts:

- Select chart region to zoom in.
- Hold Shift button and drag the graphs to pan.
- Double-click any chart to reset zoom.

The parameters set includes:

RX/TX Ref. Level (dB)



This chart displays measured RX (green) and TX (blue) signal levels. Red regions represent link outages. Default graph uses CINR

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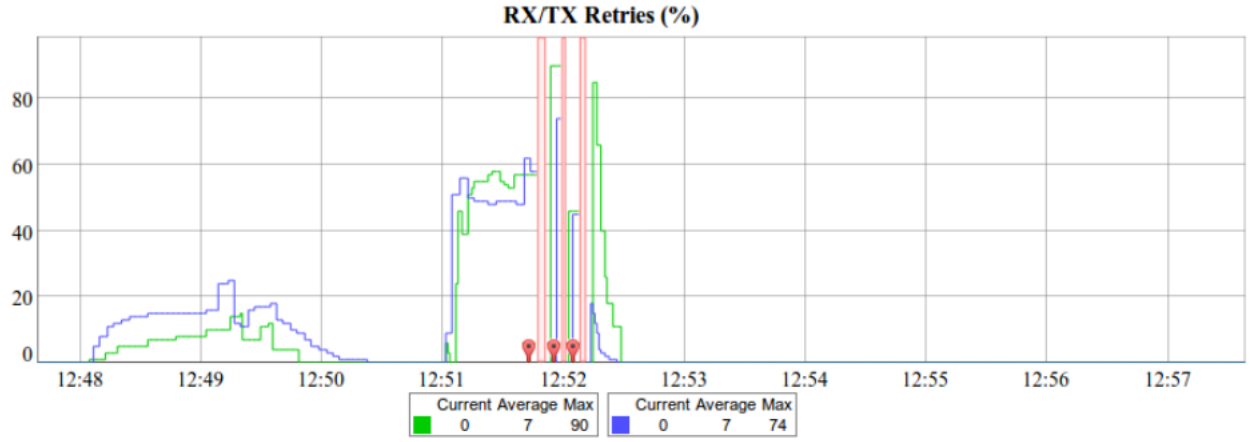
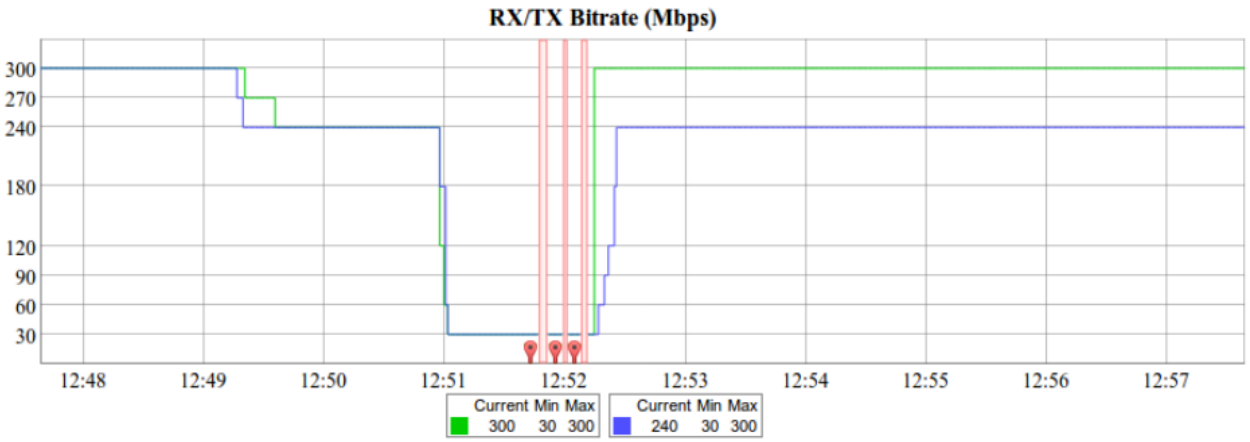
measurement method, however RSSI method can be selected from the drop-down menu.

RX/TX Retries (%)



This chart displays retry percentage –an important parameter that provides a quick estimation of the link quality. Similar to the previous graphs RX retries are represented by the green lines, TX retries – by the blue lines and link outages – by the red lines.

RX/TX Bitrate (Mbps)



The Bitrate chart displays established link bitrate. Note that the bitrate is not the same as link throughput but rather represents link quality.

Link load charts (pps & Kbps)

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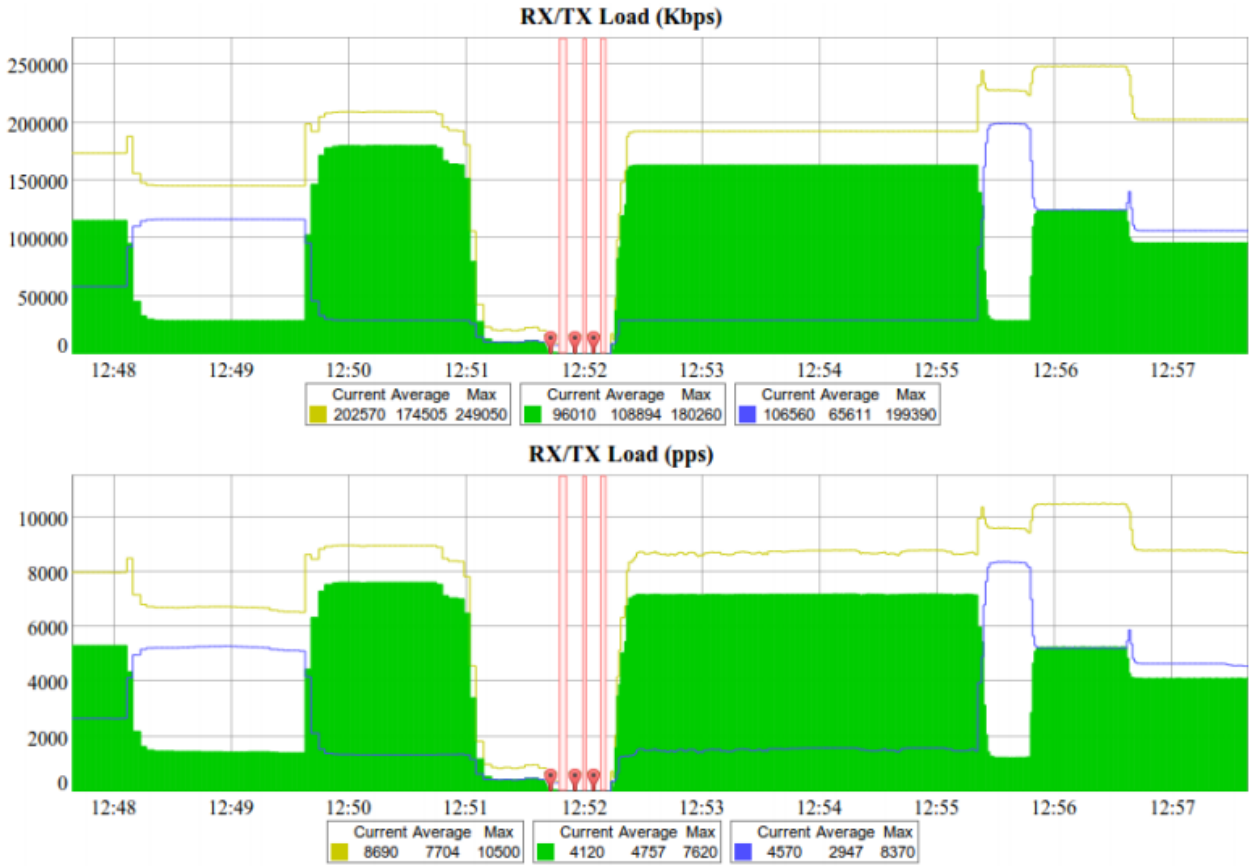
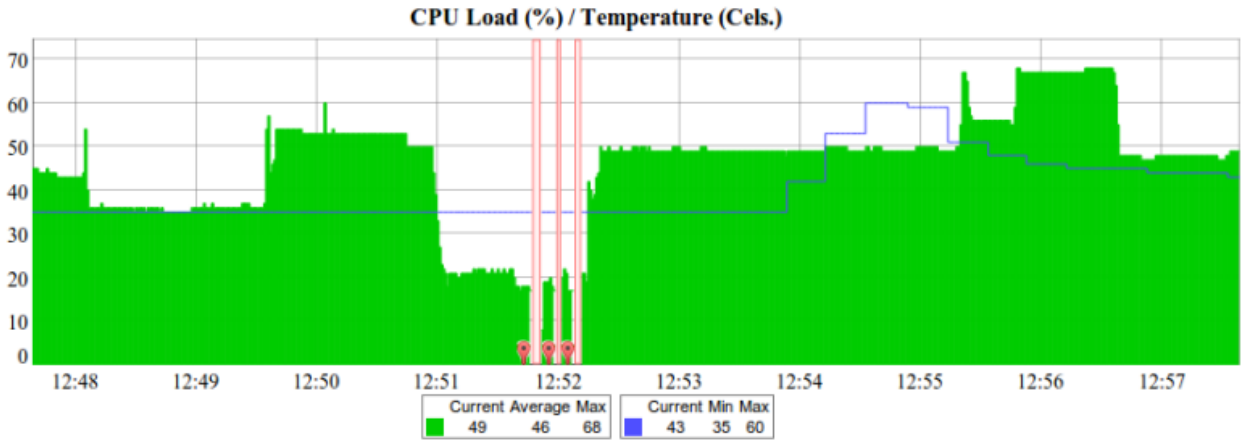


Load charts display actual link load information either in real time of for the given period. Yellow lines represent total link load, green lines – RX, load and blue lines – TX load.

CPU load / System temperature



The last chart displays current CPU load and unit temperature (for units equipped with temperature sensors).

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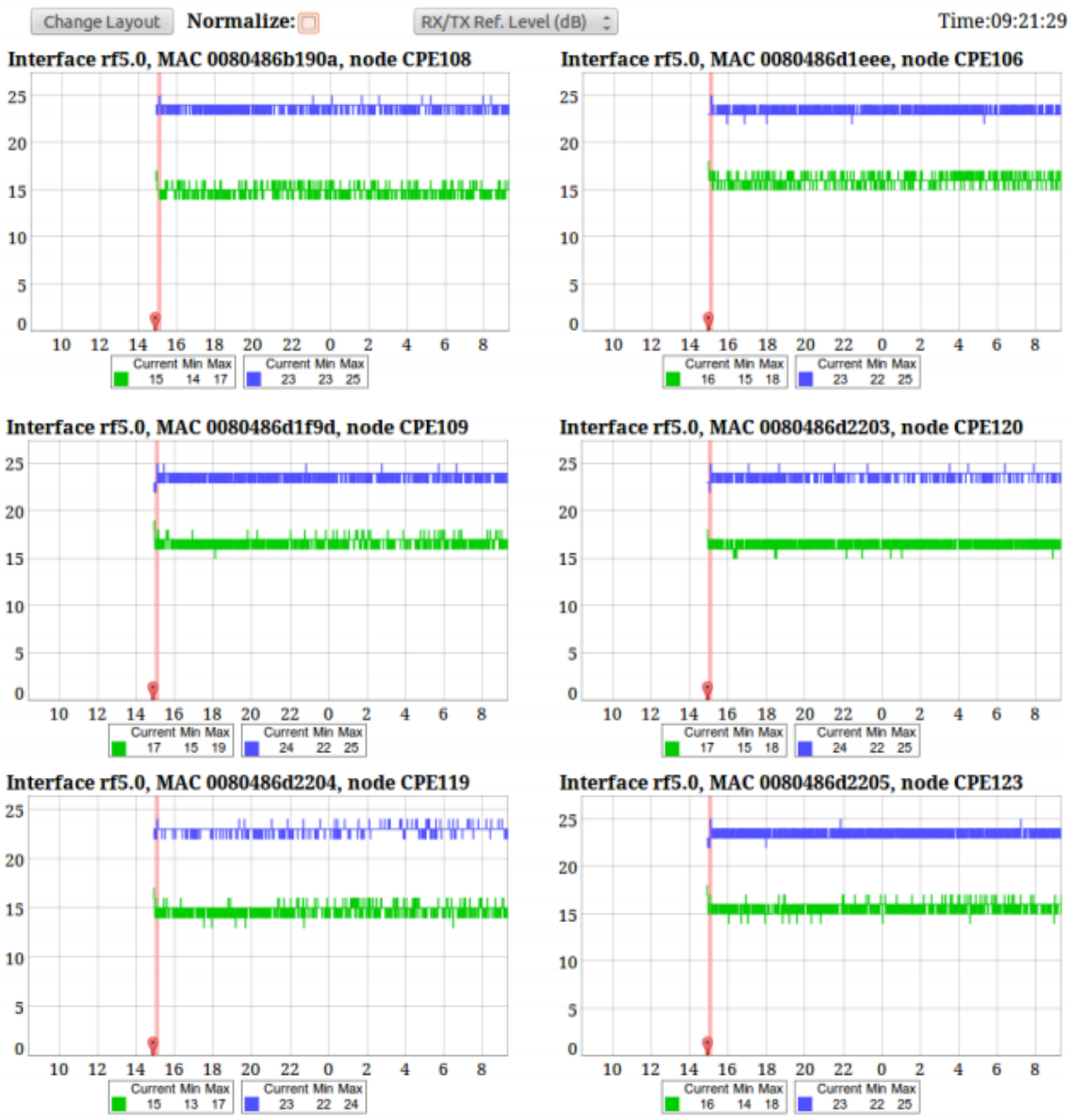
Daily Graphs

This tool allows users to monitor device parameters represented as colorful graphical charts. Supported modes are real-time monitoring and daily data logs display.


Change Layout
Normalize:
RX/TX Ref. Level (dB)
Time:09:21:29
Interface rf5.0, MAC 0080486b190a, node CPE108
Interface rf5.0, MAC 0080486d1eee, node CPE106
Interface rf5.0, MAC 0080486d1f9d, node CPE109
Interface rf5.0, MAC 0080486d2203, node CPE120
Interface rf5.0, MAC 0080486d2204, node CPE119
Interface rf5.0, MAC 0080486d2205, node CPE123

Daily Graphs page displays statistical information on all active links similar to the Stats Graphs page but collected for the last 24 hours. The drop-down menu on top of the page allows users to select link operation parameter to be displayed. Change Layout button switches page layout between one- and two-column view.

The Normalize checkbox enables/disables graph normalization.

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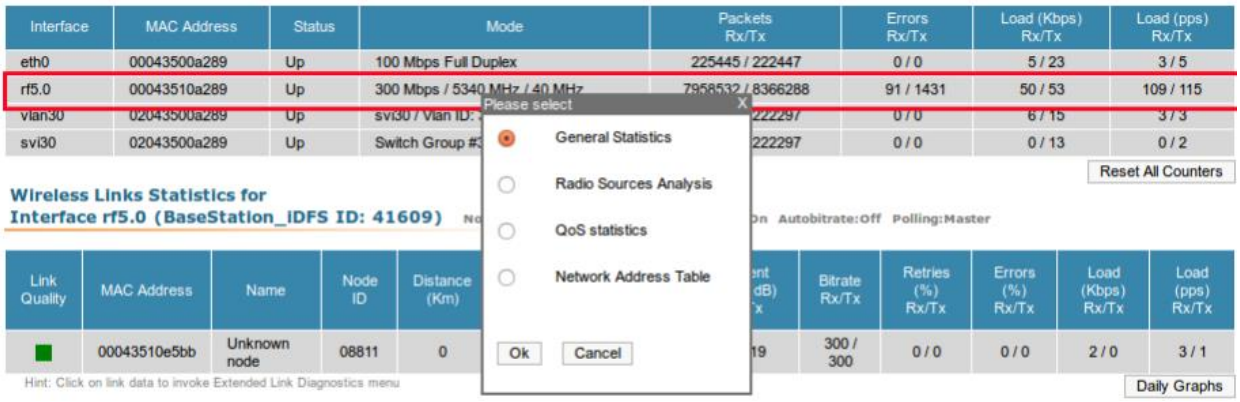
Extended Interface Statistics

Extended Interface Statistics tools allow gathering complete information and enhanced statistics on the unit's interfaces. Each interface type has its own set of available tools applicable to it.

To access the Extended Interface Statistics tools make a mouse-click on the row with the interface on which you want to get statistics in the "Interface Statistics" section (see the picture below):



Then choose the statistic tool you need from the appeared window.

General Statistics

The General Statistics tool shows statistics on the interface such as the interface mode, current status, receive and transmit statistics and so on. The actual statistics details depend on the interface type (i.e. Ethernet, RF and other).

Radio Sources Analysis

The Radio Sources Analysis tool tests the electromagnetic environment and enables to estimate utilization efficiency of the radio links, reveal sources of interference and estimate their power.

QoS statistic

The QoS statistics tool allows viewing the statistics on software priority queues for the interface. The MINT priorities is marked as PXX (e.g. P01, P02, … , P16). One can see the number of packets that came to each priority queue and the number of dropped ones.

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Network Address Table

The Network Address Table tool shows the network address table for the interface.

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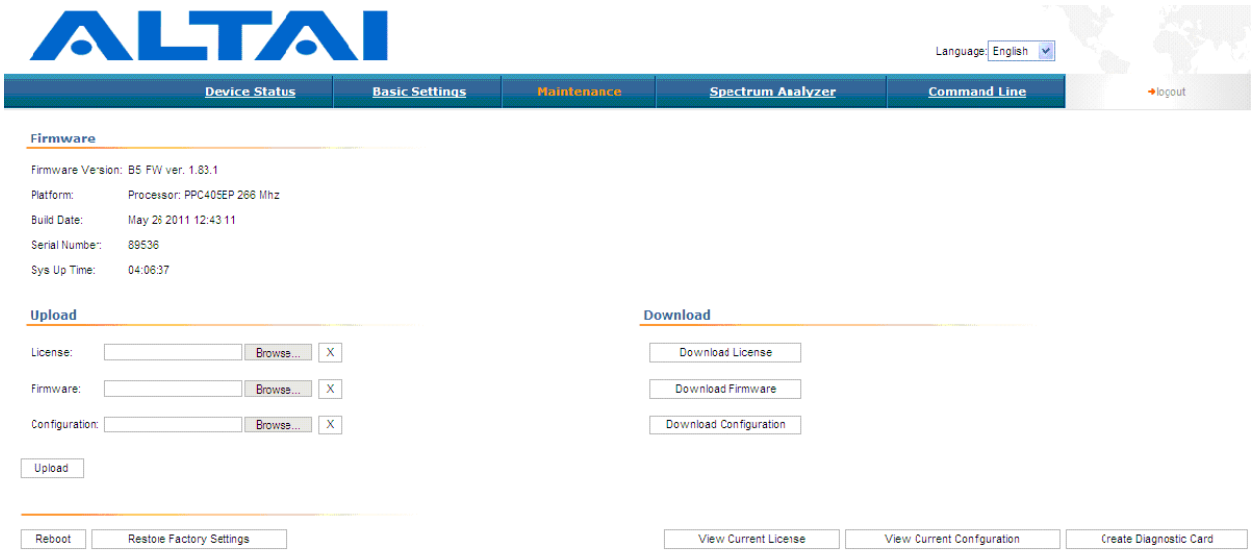
6. Maintenance



The "Maintenance" page allows performing service tasks for the device maintenance.

The «Firmware» section of the page shows current firmware version, firmware build date, serial number and system up time.

The «Upload»/«Download» sections allow uploading and downloading license files, firmware and configuration on/off the device.

The following buttons can be used:

- «Reboot» button - reboots the device
- «Restore Factory Settings» button - restores factory default configuration
- "View Current License" button - shows current device license parameters in a separate window
- "View Current Configuration" button - shows current device configuration in text format in a separate window
- "Create Diagnostic Card" button – Tech Support Reports Generator: creates a text file that contains complete information set from the device such as: full device configuration listing, system log output, license information, "mint map detail" command output, interfaces statistics and so on.

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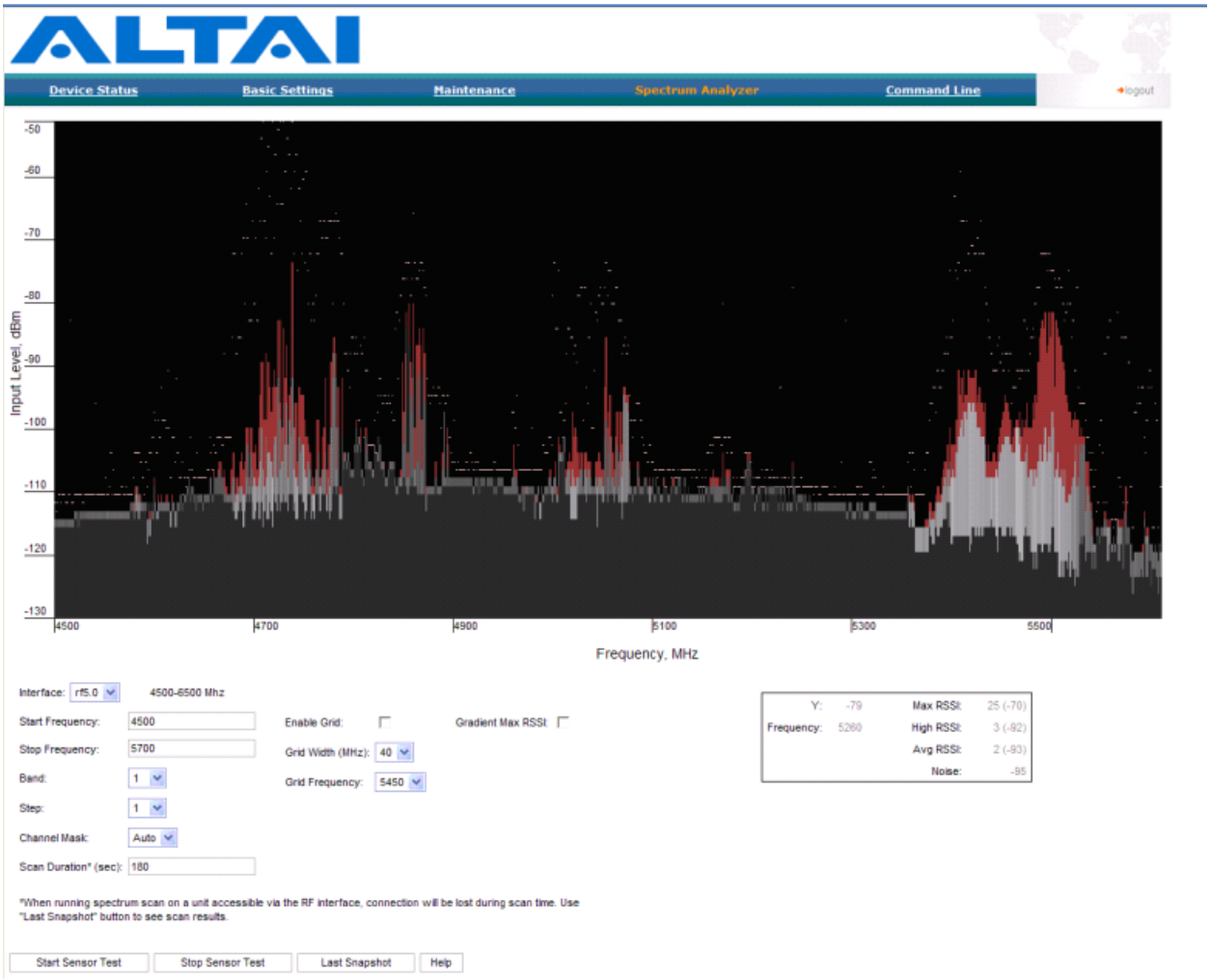
7. Spectrum Analyzer



The «Spectrum Analyzer» page provides deep analysis of radio emission sources. In this mode device scans the radio spectrum on all available frequencies. To obtain information as complete as possible, the scanning process may take some time.

The following parameters can be set to manage «Spectrum Analyzer» operation:

- Unit's radio interface
- Start frequency, determining the initial frequency for scanning in MHz
- Stop frequency, determining the ending frequency for scanning in MHz
- Band - bandwidth in MHz
- Step – scanning frequency step in MHz

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It is recommended to set 1 MHz "step" value to get more precise scanning results.

- Channel mask – specifies which antenna will scan the radio environment. "Auto" value set scanning by both antennas.
- Scan Duration – time period for scanning in seconds. After the end of this time period scanning will be stopped and radio interface will be back to normal mode operation
- Enable Grid – draws grid lines and highlights the special frequency channel on the scan output. Special highlighted frequency channel can be used to mark a channel that the device is currently working on or that is planned for using
- Grid Width –bandwidth value for the highlighted frequency channel in MHz
- Grid Frequency – central operating frequency for the highlighted frequency channel
- Gradient Max RSSI – shows gradient-color marked "Max RSSI" values on the Spectrum Analyzer output screen.

To start/stop «Spectrum Analyzer» use «Start Sensor Test»/«Stop Sensor Test» buttons.

"Last Snapshot" button outputs the final scanning results. It is used when doing a spectrum scan at the remote unit on the other side of the radio link. When running a spectrum scan at such a unit (accessible via the RF interface), connection to this unit will be lost for a scan time. "Last Snapshot" button allows viewing scan results after the connection is up again.

"Help" button – displays the help note for the Spectrum Analyzer.

You can get detailed information about scanned radio signals on a specific frequency. Just point a cursor on the needed frequency and you will see a hint with exact Signal level (dBm), Frequency (MHz), Noise Floor (dBm), RSSI (dBm), High RSSI (dBm), Max RSSI (dBm) values.

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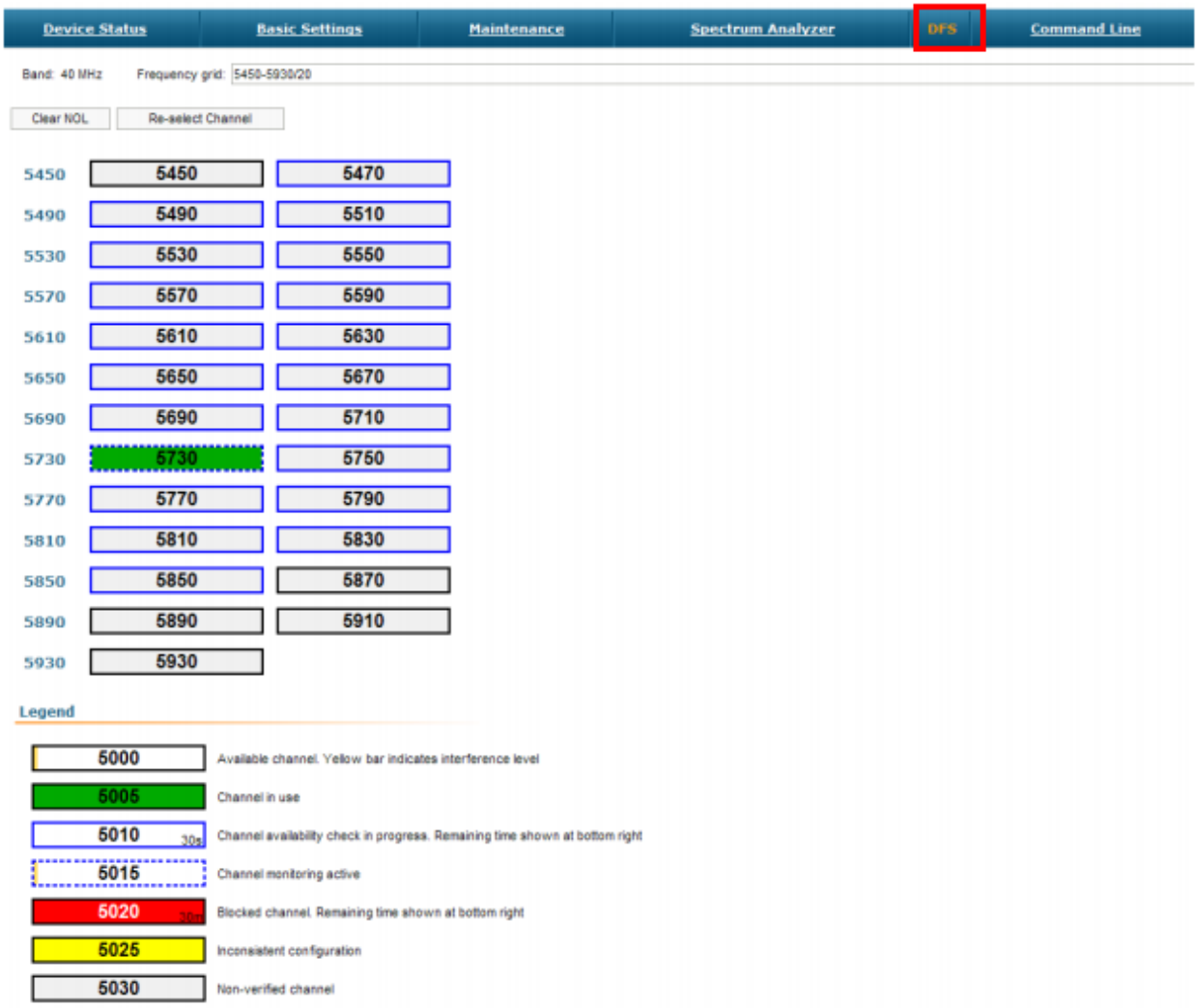
8. DFS



The «DFS» page allows monitoring and management of the DFS operation. The DFS status and availability indicators are shown for each frequency for the given band and grid (shown at the top of the page). To understand the indicators please see Legend at the bottom.

—Clear NOL ‖ button clears the non occupation list of the frequencies blocked for using due to the radars detected there and allows the DFS subsystem to rescan those frequencies. If not cleared blocked frequencies will be available for rescan after the time period shown in the right bottom corner of the frequency indicator.

—Re-select Channel ‖ button restarts the DFS scanning.

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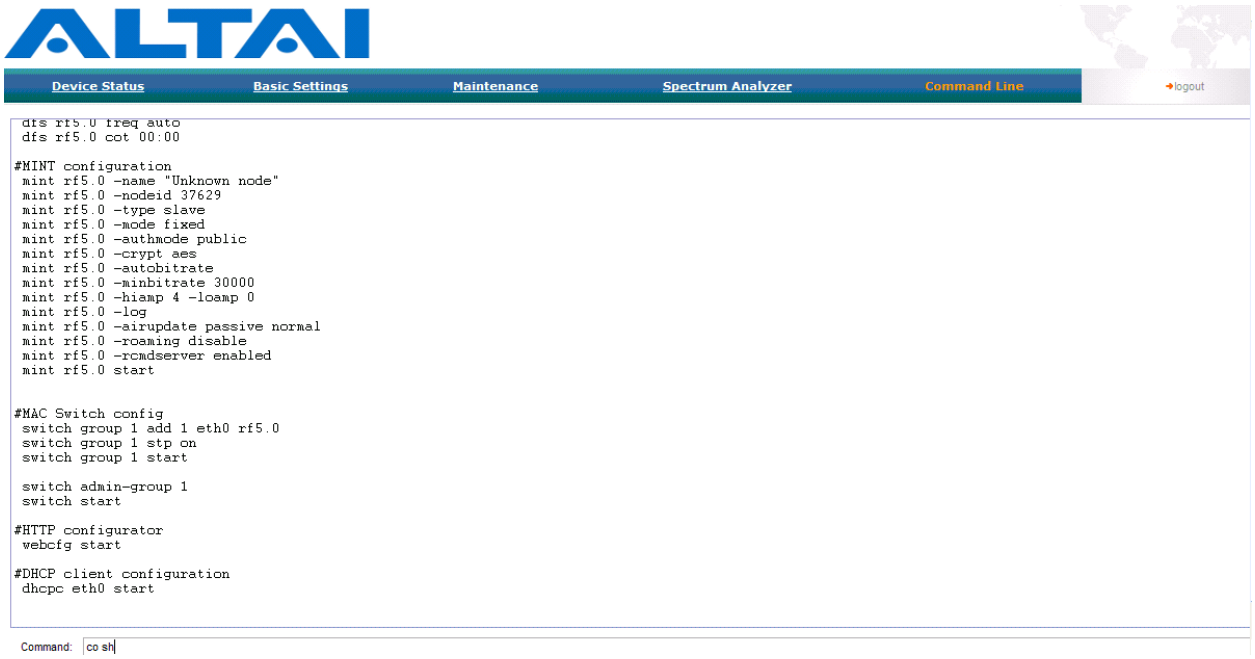
9. Command line emulation



The «Command line» page emulates CLI (command line interface) in the Web-interface. It allows managing and monitoring the device by using all the commands and functions that are available via standard CLI.

To type the commands use the "Command" field and then press either the "Execute" button on the screen or "Enter" key on your keypad. The commands output are shown in the window above.

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VII. Recommendations

1. Using Altai devices for High Bitrates

Using Altai devices on bitrates 48 and 54 Mbps (B5 Lite), 104…130 Mbps (B5, 20 MHz) and 240…300 Mbps (B5, 40 MHz) has specific requirements because of low noise immunity of high-order modulation techniques (64 QAM).

One should take all possible precautions to prevent exceeding of parasite signals over receiver sensitivity threshold. The problem is aggravated by the presence of this parasite signal in entire spectrum.

Nevertheless, when using MINT architecture in most cases it is recommended to set the maximal bitrate on the radio interface and switch on autobitrate function. This will allow the system automatically and dynamically determine the most appropriate bitrate for the current environment conditions.

2. Design of Multi-sectored Base Stations

Using of multiple Base Station sectors with high output power with limited frequency and special gap between them increases noise level on the neighboring sectors. This can lead to the decrease of its performance. So we have ultimate choice: either optimizing base station for more bitrate/less range (without amplifiers) or optimize base station for more range/less bitrate (with amplifiers).

To deal with this problem most effectively it is recommended:

1. To increase number of sectors (commonly, up to 4-6)
2. Switch to the narrower bandwidth (5 or 10 MHz)
3. Use amplifiers and directional antennas at remote subscriber CPEs.

   Remote subscribers can be configured for significantly lower than average bitrates providing more stable operating modes but those subscribers can decrease overall cell performance; so try to avoid mix solutions when the BS-CPE has a big difference for different subscribers.
4. Use B5 devices that have much higher performance, NLOS and robust characteristics than B5 Lite.

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3. Asymmetrical System Design

Following conclusions regarding using base station can be made:

- Downstream bitrate (base to CPE) is usually higher than upstream;
- Beam width of base station sectored antenna is 10 times wider than beam width of subscriber antenna;
- Trying to deploy base stations on area heights leads to raising overall noise level and reducing noise immunity;
- Subscriber SNR measured at a base station is significantly worse than that of subscriber side.
- Increasing transmit bitrate does not influence the overall working conditions and network performance;
- Increasing receive bitrate does worsen noise immunity and network performance.

Every step in bitrate increasing requires 3 dB step improvements SNR. Asymmetry in 8 times corresponds to 9 dB. It means that without link quality losses we can have 2 times bitrate difference between upstream and downstream. In order to maintain energetic parameters, we have to increase base station output power by 9 dB by means of built-in amplifier (for example to use 300-500mW devices).

4. «Bad subscriber» problem

While working in Point-to-Multipoint topology wireless network could face a problem when one of the subscriber devices has much poorer connection characteristics to Base Station than the other ones. Such subscriber device is using a considerable part of Base Station's resources. While Base Station is trying to send him a packet on a low bitrate other subscribers are waiting for this transaction to finish. Therefore, all the networks' performance will be reduced.

To lower the influence of such "bad subscriber" on the overall wireless network's performance it is recommended to decrease a priority of this subscriber (using "qm" command). In this case all the packets to "bad subscriber" will be sent after other subscriber stations already get their portions of data. This will result in wireless network performance optimization as subscriber devices' operation won't depend on the bitrate of "bad subscriber".

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5. TDM transmission

Altai equipment allows E1/T1 flows transmission via the radio channel in Point-to-Point topology. The System ensures transmission of 4 TDM channels and 45 Mbps Ethernet data simultaneously. Moreover, IW devices with TDM support allow Multi-hop TDM transmission when E1/T1 data are sent via several wireless Point-to-Point hops.

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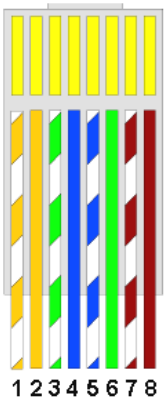
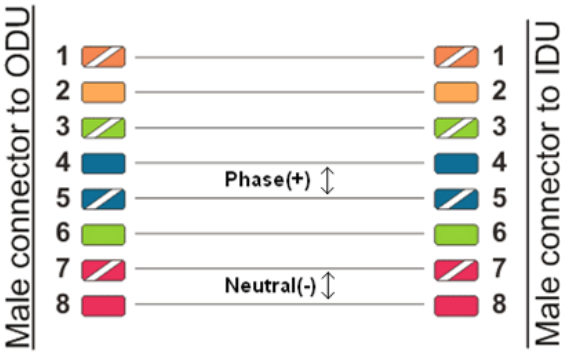
VIII. Supplementary information

1. Connectors soldering schemes

RJ-45" service cable connector soldering scheme

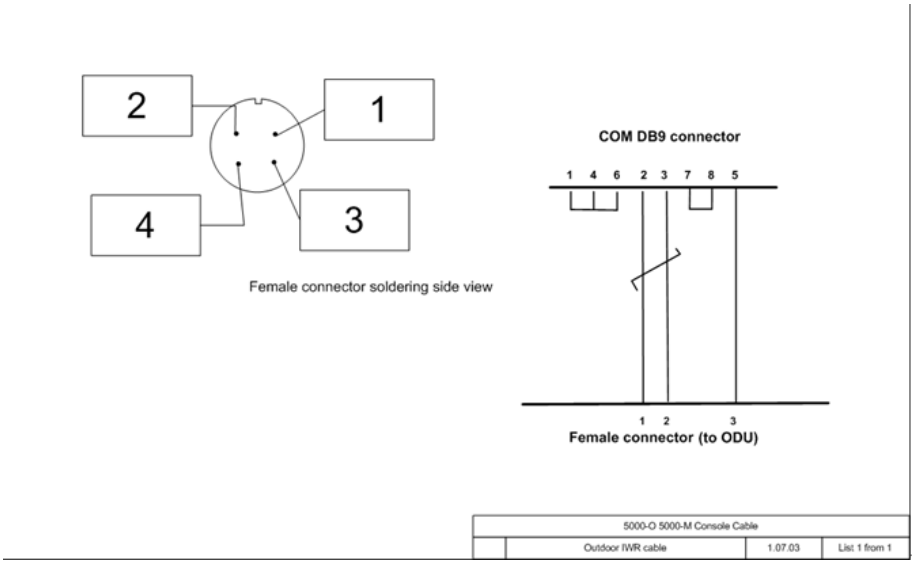
RJ-45 Male Ethernet connector





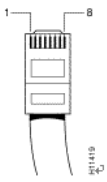
1: White-orange
2: Orange
3: White-green
4: Blue
5: White-blue
6: Green
7: White-brown
8: Brown

Console cable connector soldering scheme



"E1" Jack soldering

PIN	Signal
1	Rx tip
2	Rx ring
3	not used
4	Tx tip
5	Tx ring
6	not used
7	not used
8	not used



scheme

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